Public Health Assessment for

WELDON SPRING ORDNANCE WORKS (FORMER)

ST. CHARLES, ST. CHARLES COUNTY, MISSOURI

CERCLIS NO. MO5210021288

MARCH 8, 1995

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

THE ATSDR HEALTH ASSESSMENT: A NOTE OF EXPLANATION

Section 104 (i) (6) (F) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, states "...the term 'health assessment' shall include preliminary assessments of potential risks to human health posed by individual sites and facilities, based on such factors as the nature and extent of contamination, the existence of potential pathways of human exposure (including ground or surface water contamination, air emissions, and food chain contamination), the size and potential susceptibility of the community within the likely pathways of exposure, the comparison of expected human exposure levels to the short-term and long-term health effects associated with identified hazardous substances and any available recommended exposure or tolerance limits for such hazardous substances, and the comparison of existing morbidity and mortality data on diseases that may be associated with the observed levels of exposure. The Administrator of ATSDR shall use appropriate data, risks assessments, risk evaluations and studies available from the Administrator of EPA."

In accordance with the CERCLA section cited, this Health Assessment has been conducted using available data. Additional Health Assessments may be conducted for this site as more information becomes available.

The conclusions and recommendations presented in this Health Assessment are the result of site specific analyses and are not to be cited or quoted for other evaluations or Health Assessments.

PUBLIC HEALTH ASSESSMENT

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CERCLIS NO. MO5210021288

Prepared by

Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Defense Facilities Assessment Section
Federal Programs Branch

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations 42 C.F.R. Part 90). In preparing this document ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

Agency for Toxic Substances and Disease Registry..... David Satcher, M.D., Ph.D., Administrator
Barry L. Johnson, Ph.D., Assistant Administrator

Division of Health Assessment and Consultation..... Robert C. Williams, P.E., DEE, Director
Juan J. Reyes, Deputy Director

Exposure Investigations and Consultations Branch..... Edward J. Skowronski, Acting Chief

Federal Facilities Assessment Branch..... Sandra G. Isaacs, Acting Chief

Petitions Response Branch..... Cynthia M. Harris, Ph.D., Chief

Superfund Site Assessment Branch..... Sharon Williams-Fleetwood, Ph.D., Chief

Program Evaluation, Records, and Information Services Branch..... Max M. Howie, Jr., Chief

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National Technical Information Service, Springfield, Virginia
(703) 487-4650

FOREWORD

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the *Superfund* law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and clean up of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by a site and recommends ways to stop or reduce exposure in its public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions

of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state and federal agencies, the companies responsible for cleaning up the site, and the community. It then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they have provided is accurate and current. When informed of ATSDR's conclusions and recommendations, sometimes the agencies will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (E-56), Atlanta, GA 30333.

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SUMMARY

The Weldon Spring Ordnance Works (WSOW), an explosives production facility, was operated by the Atlas Powder Company from October 1940 through August 1945. The plant was built on a 17,232 acre tract of Army property in St. Charles County, Missouri.

For regulatory and remedial purposes, the original Weldon Spring Ordnance Works is divided into two National Priority List (NPL) sites. One NPL site is the responsibility of the U.S. Army. The other is the responsibility of the U.S. Department of Energy (DOE). The formal definition of the Army WSOW NPL site includes Weldon Spring Training Area (WSTA), Missouri Department of Conservation areas (August A. Busch Memorial Conservation Area and Weldon Spring Conservation Area) and numerous other small properties within the original facility boundaries. The DOE NPL site includes the Weldon Spring Chemical Plant (WSCP), Raffinate Pits and the Quarry.

This public health assessment is an evaluation of the possible public health effects of hazardous materials from U.S. Army portions of the former ordnance works. A future public health assessment will evaluate the DOE facilities.

The Weldon Spring NPL sites are in eastern Missouri between the Mississippi and Missouri Rivers, approximately 30 miles west of St. Louis. The WSOW Site was placed on the National Priority List (NPL) in 1990. Since World War II, much of the original WSOW land has been leased or sold as surplus property. Of the property sold, about 15,000 acres has been converted into two conservation areas maintained by the Missouri Department of Conservation.

Past operations have resulted in the contamination of the environment with a variety of explosives-related compounds, including TNT, DNT, and various metals. In the past, wastewaters were discharged into lagoons where the settling of explosives occurred. From the lagoons, wastewater overflow then discharged to the facility wastewater treatment plant and from there to surface water. Contaminants also migrated into soil and the groundwater (i.e., water within the earth that supplies wells and springs) via spills and operational releases from the wastewater piping systems.

The contamination of groundwater by WSOW wastewater has been known since the 1940's. Off-site groundwater contamination by nitroaromatics was documented in 1988, north of WSTA in private wells serving the Twin Island Lake Resort campground. The U.S. Army began providing drinking water to the resort in 1989. Bottled water was provided until public water supply lines were installed.

Offsite groundwater use (now prevented by alternate water sources use), consumption of possibly contaminated game and fish from the conservation areas adjacent to WSTA, and

contact with contaminated soil areas are the only possible routes through which the public may come into contact with contaminants from past ordnance production activities at WSOW.

ATSDR considers present groundwater and onsite soil contamination to be categorized as No Apparent Public Health Hazard, as exposure to contaminants could occur, but institutional controls have mitigated the potential for exposure to levels that might be a health hazard. Based upon the available data, in the past, private wells may have contained contaminated groundwater and workers may have been exposed to contaminated soil. Therefore, for the time prior to institutional controls, ATSDR classifies WSOW in the category of an Indeterminate Public Health Hazard. Institutional practices initiated in 1988 and since, have reduced or eliminated this potential exposure pathway. Data is insufficient to determine potential contamination in wildlife. However, existing levels of contaminants in other environmental media are low enough that even in the event that wildlife were to bioaccumulate contaminants, the levels would not likely be high enough to result in harmful exposures to people. Also, informal observations by Missouri Department of Conservation report that fish consumption in the conservation areas is generally not subsistence in nature. ATSDR considers consumption of potentially contaminated game and fish associated with WSOW to be categorized as No Apparent Public Health Hazard.

Additional data concerning contamination outside the Weldon Spring Training Areas is being gathered and other sampling studies are being conducted to better define the source and migration of contaminants. ATSDR recommends continuing the evaluation of potential contamination in fish and groundwater. ATSDR is continuing the development of a public health assessment for public health issues regarding the DOE NPL facilities at Weldon Spring.

There is a limited potential for completed environmental pathways resulting from activities at the former WSOW, therefore extensive review of health outcome data would not provide useful information for this health assessment. However, based on the concern expressed by local members of the public about leukemia incidence, information provided by the Missouri Department of Health was reviewed. This information indicated that total childhood leukemia incidence and mortality rates within St. Charles County are not significantly elevated relative to state-wide rates. The concern regarding childhood leukemia, with general concerns about the safety of remedial activities comprised the dominant community health concerns for this site.

BACKGROUND

Site Description

The former Weldon Spring Ordnance Works (WSOW), an explosives production facility, was operated by the Atlas Powder Company from October 1940 through August 1945. The plant was built on a 17,232 acre tract of Army property in St. Charles County, Missouri (1). WSOW is located in eastern Missouri between the Mississippi and Missouri Rivers, approximately 30 miles west of St. Louis (See Figure 1).

The Weldon Spring Ordnance Works Site was placed on the National Priority List (NPL) in 1990. As currently defined for regulatory and remedial purposes, the Weldon Spring Ordnance Works (WSOW) includes the U.S. Army Weldon Spring Training Area (WSTA), Missouri Department of Conservation Busch and Weldon Spring Conservation Areas and several smaller properties within the original WSOW area (See Figure 2). This public health assessment considers the effect on public health of hazardous materials resulting from activities which occurred at the Department of Defense (DOD) WSOW Site.

The WSOW Site *does not* include the Department of Energy (DOE) Weldon Spring Site which is composed of the Chemical Plant (WSCP), Raffinate pits and Quarry areas. These DOE areas are grouped into the DOE Weldon Spring Site which is located within the Weldon Spring Ordnance Works Site. The DOE Quarry was placed on the NPL in July 1987 and the Chemical Plant Area was added to this listing in March 1989. The evaluation of public health effects related to the DOE sites will be made in a separate public health assessment.

The facility manufactured trinitrotoluene (TNT) and dinitrotoluene (DNT) from October 1941 through August 1945. (Note: For reference purposes, Appendix A is a glossary of abbreviations and acronyms for use throughout this document.) The facility ceased operation shortly after World War II (WW II). The plant was decommissioned in 1946 and portions of the former WSOW currently are owned by several organizations, including; the village of Weldon Spring Heights, Francis Howell School District, University of Missouri, Missouri Department of Conservation, Missouri Department of Highways, U.S. Army and the U.S. Department of Energy. At present 1,655 acres remain in Army control under the U.S. Army Engineer Center and Fort Leonard Wood, as the Weldon Spring Training Area (WSTA) of the U.S. Army Reserve (Figure 2).

Tracts totalling about 61 acres are currently property of the Francis Howell School District. The remaining 15,000 acres of the original WSOW land is now two conservation areas maintained by the Missouri Department of Conservation. The August A. Busch Memorial

Conservation Area is about 8,000 acres and the Weldon Spring Conservation Area encompasses 7,000 acres (See Figure 2).

In 1954, the Army transferred 205 acres of land to the Atomic Energy Commission (AEC). The AEC property is now controlled by the DOE and is designated as the Weldon Spring Quarry, Weldon Spring Chemical Plant (WSCP) and Weldon Spring Raffinate Pits. The DOE facilities are now termed the Weldon Spring Site Remedial Action Project (WSSRAP) (See Figure 2).

Areas of Consideration

For the purpose of this public health assessment, three separate areas will be evaluated. The first is the WSTA, the portion of the original WSOW which is currently controlled by the Army. The second area is the remainder of original WSOW (including the Busch Conservation Area, Weldon Spring Conservation Area and the University of Missouri - Missouri Research Park). The portion of the original WSOW outside of Army or DOE administration will be referred to here as "the conservation areas". The third area consists of the adjacent properties outside the original boundaries of the ordnance facility. (See Figure 2)

As stated previously, the purpose of this public health assessment is to consider the public health effects of contaminants resulting from U.S. Army operations in the former WSOW site. The effects of contaminants resulting from DOE operations at the WSCP, Raffinate Pits and Quarry areas are to be considered in a separate document.

WSTA includes 16 former TNT and DNT production lines and portions of two other TNT production lines. Although the majority of the production facility structures were razed by bulldozer and burning in 1956 and 1957 (2), much of the underground pipeline used to transport explosives-contaminated wastewater remain in place on the WSTA.

Several areas now within the conservation areas were used for disposal of waste and debris. These include one dump, six burning grounds and three wastewater lagoons (3).

The offsite area evaluated consists of property outside the boundaries of WSOW. The principal medium of concern for offsite area is groundwater. Environmental sampling offsite has revealed trace amounts of contaminants from WSOW sources in some offsite private wells north and northeast of WSOW facilities.

Site Visit

ATSDR staff have made several visits to the Weldon Spring area to meet with site personnel, local, state, and federal officials, and concerned citizens. The first visit was a tour of the Weldon Spring Training Area and Former Ordnance Works facility on February 6-8, 1991. ATSDR staff met with representatives of the Army and the Missouri Departments of Health and Conservation. A site visit was made to the DOE Weldon Spring Site on June 8-12, 1992. This visit included a tour of the DOE facility and meetings with representatives of federal and state regulatory agencies, the St. Charles County School Administration, and the St. Charles Countians Against Hazardous Waste.

ATSDR staff also attended a public meeting sponsored by the U.S. Army Corp of Engineers (COE), November 20, 1992, and a public hearing sponsored by the DOE and the EPA (December 16, 1992). Concenrs regarding cancer were presented at the November 1992 meeting. The public hearing was attended by approximately 150 concerned residents with 25 people presenting specific comments regarding the "Proposed Plan for Remedial Action at the Chemical Plant Area of the Weldon Spring Site." Other individuals or groups indicated that they would provide the DOE and EPA with written comments. Community health concerns were collected at this meeting. The specific concerns are addressed later, in the Community Health Concerns section of this public health assessment.

ATSDR staff attended an EPA-sponsored demonstration for ex-situ bioremediation of explosives contaminants during a trip to the site on April 5 - 8, 1994. ATSDR staff met with representatives of EPA, the Army and the Missouri Departments of Health and Conservation. During that visit ATSDR staff also met with members of the public and medical community to discuss concerns. As a result of these meetings, follow-up public availability sessions were planned. These public availability sessions were held July 11 - 12, 1994, at two public schools in the vicinity of the Weldon Spring NPL sites. Approximately 24 members of the public participated.

Demographics

The Weldon Spring sites are located in a sparsely populated rural area of St. Charles County approximately 30 miles west of downtown St. Louis. St. Charles County had a population increase of 48 percent from 1980 to 1990 (from 162,000 to over 212,000) and has more than doubled in population since 1970; most of this rapid growth is due to people moving out from the city of St. Louis to the suburbs.

The site is located in Census Tract 3122.01 and 3122.02 (see Figure 3). These tracts are relatively large and is very sparsely populated (less than 30 persons per square mile); much of the land is devoted to agricultural use. The percentages for sex, race, Hispanic origin, age, and housing are generally comparable with those for the county, except that there is a

somewhat lower percentage of children under age 10 and a much higher median value for owner occupied housing. Many of the homes in this area are large two-story single family homes on large lots (as noted on the site visit), which would account for much of the increased value.

The August A. Busch Memorial Conservation Area occupies the northern portion of WSOW and covers much of Block Group 3 in Census Tract 3122.02 (see Figure 3). The only population or housing variable for this area which differs considerably from the county averages is percent of households which are mobile homes (over 55 percent).

Extensive private well monitoring is conducted in Census Tract 3111.04. This area is much more densely populated than the other two tracts. Both persons per household and percent of children under age 10 are higher than the county averages, while percent age 65 and over is relatively low; these figures suggest that a number of young families have moved into this area, which is consistent with the "suburbanization" of recent years. Both median housing value and monthly rent are relatively high.

Land Use

Most of the property is wooded, with low shrubs and trees. Open grassy areas exist in the northern areas of the Busch Conservation Area and the Missouri Research Park. Portions of the Busch Conservation Area are used as leased cropland by local farmers. The southern and eastern portions of the conservation areas are comprised of more rugged terrain and are heavily wooded. There is reportedly very little public usage of this area (1).

In the northern portion of WSOW the topography is characterized as rolling hills. The southern portion of the site is characterized by a rugged topography, consisting of narrow, irregular drainage systems with short, steep gradient streams. The transition between these hydrologic regimes occurs in the southern portion of the WSTA and corresponds with a primary drainage basin and groundwater divide; north to the Mississippi River, south to the Missouri River (5).

Annual precipitation for this area averages approximately 37 inches/year with more than half occurring as rainfall between March and July. Annual evaporation, based on average free water surface evaporation (1956-1980 data) is approximately the same as precipitation (~37 inches/year). Prevailing winds are from the south during summer and fall, and from the northwest and west-northwest during winter and spring. Average wind speeds are about 8.7 mph for May through November and 10 mph for December through April (1).

Of the original 17,232 acre tract of Army property, approximately 8,000 acres to the north are now the August A. Busch Memorial Conservation Area, and approximately 7,000 acres

to the south are now the Weldon Spring Conservation Area. Both of these areas are maintained and administered by the Missouri Department of Conservation (MDOC). The MDOC's multiple-use philosophy of land management includes: use of the land as forest and area for a wide variety of wildlife and birds; 32 stocked fishing lakes; and land leased for farming (grains and forage crops) on approximately 1000 acres south of the quarry along the Missouri River floodplain. No livestock are raised on the leased areas.

Seasonal hunting for squirrel, groundhog, dove, rabbit, white-tailed deer and wild turkey occurs by special permit. Hunting dog field trials take place on portions of the conservation management areas, and there is a practice shooting range on the August A. Busch area. Other recreational use of the land includes hiking trails, bird-watching, and a variety of educational conservation activities. The Katy Trail, a Missouri Department of Natural Resources (MODNR) park, is a major east-west hiking and bicycling trail along the former Missouri-Kansas-Texas railroad right-of-way; the trail passes within ¼ mile of the WSSRAP quarry. Edible aquatic species in the lakes in the August A. Busch area include black bass, white bass, channel catfish, flathead catfish, blue catfish, crappie, bluegill, carp, sunfish, and crayfish.

The WSOW cover two physiographic provinces: the northern portion of the site is within a dissected glacial till plain which is characterized by moderately undulating, northward dipping topography comprised of thin glacial deposits overlying limestone bedrock. The southern portion of former WSOW was not glaciated during the Pleistocene. The surficial sediments consist of alluvium and residuum overlying the limestone bedrock (5).

The unconsolidated overburden consists of silty, sandy and gravelly clays and silts, which coarsen in grain size downward. Underlying these sediments is a series of consolidated sedimentary units, predominantly limestones. Deeper units are interbedded with sandstones and shales. Geologic studies have determined these formations to be highly fractured. Over time, as groundwater moves through these fractured limestones, it dissolves the rock along the cracks and fractures, and in the naturally occurring pore spaces. This dissolution results in extremely porous formations in which groundwater flows are difficult to discern in detail. These types of geologic formations are termed "karstic". Because of the extreme porosity and fracturing, groundwater flow can vary greatly across slight geographic distances as well as varying across short vertical distances. As a result, it is often difficult or impossible to accurately determine groundwater flow patterns within an aquifer system (a water-bearing layer of rock, sand or gravel). Also, surface water and groundwater systems are often interconnected in karstic areas, with both losing streams and springs, adding to the complexity of the groundwater flow regime. It is therefore difficult to trace contaminant plume pathways in karstic environments. For the former WSOW and vicinity, the best that can be said is that groundwater flow across the area generally follows the pattern of surface water flow (1) (See Figure 4).

Three aquifer systems have been defined for the area surrounding the former WSOW. The shallowest systems are the sand and gravel alluvial aquifers of the Mississippi and Missouri Rivers, and tributaries. There are also the shallow and deep bedrock aquifers, separated by a leaky confining layer, termed an aquitard. Public water supplies in the area are predominantly supplied from the alluvial and deep bedrock aquifers (1).

St. Charles County currently owns and operates the former ordnance works wellfield which is located along the Missouri River approximately one half mile south of the Quarry site. Eight wells pump an average of 12 million gallons per day (MGD) (22 MGD maximum) from the alluvial aquifer of the Missouri River. Well depths vary from 100 to 130 feet. Water from the wellfield is sold to the St. Charles County Public Water District #2 and the Missouri Cities Water Company, serving about 60,000 people throughout St. Charles County. There are also approximately 60 private wells in the vicinity of the Weldon Spring Ordnance Works being monitored by the state of Missouri Department of Health (11).

Health Outcome Data

Health outcome data (HOD) document health effects that occur in populations. The data can provide information on the general health status of the community living near a hazardous waste site. It can also provide information on patterns of specified outcomes. Some examples of health outcome databases are tumor registries, birth defects registries, and vital statistics.

Because of the likelihood that no exposures occurred, and considering that the contaminants resulting from ordnance production are not likely to cause leukemia, extensive review of these data would not provide useful information for this health assessment. However, based on the concern expressed by local members of the public about leukemia incidence, information provided by the Missouri Department of Health was reviewed (14,15). This information indicated that total childhood leukemia incidence and mortality rates for St. Charles County are not significantly elevated relative to state-wide rates. This issue is discussed in more detail in the "Community Health Concerns" section of this document. ATSDR investigations of hospital release data and mortality records for the area have not revealed any health problems which could be related to either of the Weldon Spring sites (16). Additional evaluations of specific cancer incidence will be made of health outcome data as a part of the public health assessment for the DOE facilities.

ENVIRONMENTAL PATHWAYS, ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

Introduction

The release of contaminants into the environment from WSOW has been documented. To determine whether people are exposed to on-site contaminants or to contaminants migrating from the site, ATSDR evaluates the environmental and human components that lead to human exposure. This pathways analysis consists of five elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present. The release of contaminants into the environment does not always result in exposure. For adverse health effects to occur, two principle criteria must be met. The exposure pathway must be completed, and the exposure dose must be sufficient to cause adverse health effects.

WSOW Environmental Pathways

Chemicals routinely manufactured, handled, and stored at WSOW during its operation have been detected in WSTA soil, and in offsite groundwater, surface water and, to a lesser extent, in biota. For the purpose of this public health assessment, three areas are evaluated for hazardous chemicals from WSOW ordnance operations. These are; WSTA, the portion of the original WSOW which is currently controlled by the Army; the "conservation areas", including the Busch Conservation Area, the Weldon Spring Conservation Area, and the University of Missouri Research Park; and the adjacent off-site areas that are not a part of the former WSOW, but which may have received contamination (See Figure 2).

The WSOW and WSTA Remedial Investigation (RI) environmental sampling programs provide information about the extent of contamination from the ordnance works (1,18, 30). Contamination resulting from past ordnance production activities at WSOW has been detected in groundwater and soil onsite. Soil contamination has been found in restricted portions of the conservation areas. Very limited amounts of contamination have been found in surface water in the conservation areas and in the groundwater offsite. The main potential public health issues evaluated in this document are; groundwater contamination offsite, possible biota contamination in the conservation areas, and localized soil contamination within the WSTA and in limited and isolated areas of the conservation areas. People who may have been exposed include, respectively; users of private wells, hunters and anglers using the conservation areas, and site workers, army personnel or trespassers at WSTA. As the following sections will show, although groundwater has been contaminated, current institutional controls have eliminated this as a medium of concern for a completed pathway.

Also, soil onsite, and in restricted conservation area locations, is contaminated. Institutional controls have also eliminated soils as a medium of concern for a completed pathway. Fish and game are potentially exposed to contaminants from past ordnance production activities. The potential exposure of wildlife to these chemicals is at a level low enough that consumption of biota from the WSOW and vicinity is not a significant concern. Table 1 presents a summarized evaluation of the environmental pathways that may be of concern. The following sections describe the potential for contact with contaminants resulting from activities at WSOW. Issues related to contaminants in environmental pathways associated with operations at the DOE NPL facilities will be evaluated in a future public health assessment.

Nature and Extent of Contamination

Introduction

The contaminants discussed in the public health assessment are evaluated based on known or possible human exposure, and whether exposure to the contaminants has public health significance. ATSDR and other agencies have developed comparison values (CVs) to provide guidelines for estimating the media concentrations of a contaminant that are unlikely to cause adverse health effects, given a standard exposure rate and standard body weights. These CVs are developed to address health effects resulting from long-term (life-time) exposures. As a result, the use of these levels in discussing short-term, infrequent exposures provides an extremely conservative, (ie. protective) evaluation of the potential health hazard. As will be discussed in the following sections, the potential exposures to contaminants related to former WSOW activities will be short-term and infrequent. Comparison values used in the evaluation of these contaminants are described in Appendix B. The following briefly describes the pathways evaluated for contaminants related to U.S. Army operations at the Weldon Spring Former Ordnance Works.

Localized areas of soil contamination have been documented in former production, storage or waste disposal areas, on WSTA and within the conservation areas. Access to contamionated areas within WSTA is restricted to remediation personnel. There is also limited access provided to the U.S. Army Reserve and other military units for training purposes. Training exercises are restricted to areas away from contaminated soil (17). Figure 5 shows the locations of existing training areas and those proposed for 1994, and their relationship to contaminated areas within WSTA. Areas considered for training activities are evaluated for potential contamination exposure to troops. Use for training in these areas is considered only after the areas have been determined safe by the Army and regulators (7). Portions of the conservation areas with extensive localized soil contamination have been fenced. The

principal potential receptors of contamination in soils within former WSOW would be trespassers. These individuals would be exposed infrequently for short time periods.

Contaminants have been found in groundwater on WSTA and, to a limited extent, within the conservation areas and offsite. During and after the operational life of the former WSOW, drinking water has been provided by the WSOW (now St. Charles County) Wellfield. Use of onsite groundwater as a drinking water source is currently prohibited. Offsite, public water supplies were provided at the single location where groundwater wells were observed to be contaminated, even though contaminants detected were not at levels of concern (11). Although potential exposures prior to 1988 can not be determined, there is currently no evidence of groundwater contamination in private wells offsite which are monitored by Missouri Department of Health (MDOH) (13, 34).

Very low levels of explosives and metals have been observed in some surface water bodies and sediment. The potential exists for local biota to be exposed to contamination from surface water and sediment or from contaminated soil, although sample data supports that no contamination at levels of concern has been detected in biota collected from the former WSOW (9,45,46). The potential receptors would be hunters or anglers who frequently consume fish and game that could contain contaminants.

Weldon Spring Training Area (WSTA)

The area currently designated as WSTA comprises about 1700 acres of the original 17,00 acres of WSOW. With exceptions which will be described in the following sections, almost all fo the waste areas are located in this 1700 acres. At the peak of operations, during WW II, WSOW consisted of 18 TNT and two DNT plants. Each TNT plant consisted of mono-, bi- and tri-nitration houses, where toluene was nitrated in three stages. Additional processing occurred in the wash houses, where crude TNT was purified with a "sellite" (sodium sulfite) solution. Two sellite production facilities were located in the southern portion of WSTA. Melting, dewatering and recrystallization of TNT occurred in grainer houses. DNT was produced in nitrating houses and sweating houses, where the product was heated in a "sweat pan" to drive off impurities. After purification, molten DNT was cooled to a granular form. The granulated product was screened and packed for shipment. Figure 6 shows the locations of the various former production and waste management facilities at WSTA.

Primary waste products of explosives production process are red and yellow water. Red water is produced during the TNT purification process and consists of water, ash, inorganic salts, dyes and relatively small amounts of TNT. Yellow water is essentially a more dilute form of this waste. Approximately 83,300 feet of buried (2-5 feet deep) wooden pipeline remain at WSTA. Three pipeline systems conveyed red and yellow water from settling tanks at the TNT and DNT production lines to wastewater treatment plants along the southern

boundary of the site. A fourth pipeline subsystem carried treated and untreated wastewater from the treatment plants to a final discharge point off site to the southeast, ultimately reaching the Missouri River by surface flow (1).

There are 22 buildings remaining on the WSTA. Of these, 16 are still in use, leaving 6 abandoned buildings (1,7). There are also extensive remains of partially demolished structures, building foundations, some with open basements, and cisterns, some partially filled with water, throughout the site. The concentrations of soil contaminants occur in and around the remains of the explosives production structures.

The burning grounds at WSOW were used to dispose of TNT products during site decontamination activities. The burning ground on WSTA is designated burning ground five/six. It is located in the extreme southwestern portion of WSTA. All burning grounds are fenced, and are overgrown with brush.

The landfill, located in the north central portion of WSTA, is a 550 by 250 foot area. The landfill is not currently in use. No evidence of recent disposal activity was found during RI activities. It has reportedly been used for Army earth-moving equipment training exercises (1). It is generally flat, with several small, soil-covered piles. The site is vegetated with scrub brush.

The dumps are located in the northeastern and south central portions of WSTA. They are about 12,000 square feet and 34,000 square feet, respectively. Both are vegetated with scrub brush. The southern site was excavated out, re-closed and capped with clay, while the northern site was left uncovered with visible piles of building material and scrap metal.

Seven lagoons were constructed for waste water storage prior to construction of treatment facilities (Figure 7). Of these seven, the four were filled with soil by December 1943, when treatment facilities became operational. Also, two were incompletely filled and still contain variable amounts of runoff water. There were four lagoons on WSTA and three outside WSTA. Lagoon One, to the east of WSTA was earth filled. Lagoon Two, within WSTA was also earth filled. Lagoon Three, located outside WSTA was never filled and contains runoff rainwater. Lagoons Four and Five, on WSTA, were reported to be filled. But, apparently due to settling and erosion, these two lagoons impound variable amounts of runoff rainwater. Lagoons Six and Seven were not filled. Lagoon Six seasonally holds small amounts of water (8). Lagoon Seven to the north of WSTA is currently water-filled and is designated Lake 16.

The contamination of groundwater by ordnance production activities has been known since the first investigation of contamination at WSOW was conducted by the Army in 1943. Contaminated groundwater was traced from the facility to offsite springs. Local springs and surface water tributaries were observed to be contaminated. Five demolition and cleanup

actions have been undertaken since the 1940's. These occurred in 1944, 1945-46, 1950-57, 1961-62 and 1967. These actions were undertaken to mitigate the sources of contamination and did not involve activities aimed at cleanup of water contamination (3). In 1976, the Army conducted environmental studies to estimate contamination and contaminant migration, focusing on groundwater pathways. In 1987, The COE was tasked with developing a Remedial Investigation/Feasibility Study (RI/FS) for WSTA (18, 30).

Generally, the highest detected concentrations of contaminants were measured in samples collected from soils and sediment onsite, and groundwater onsite (18, 30). The WSTA RI sampling activities consisted of three phases, conducted from Fall 1988 through Fall of 1989. The first phase assessed surface soil contamination within the TNT and DNT production facilities, wastewater treatment plants, the sellite and acid production plant areas, laboratory buildings, and stream beds exiting the perimeter of WSTA. The second phase assessed surface soil contamination in the troop training facilities, including training areas, firing ranges, access roads, air strip and helipad areas, bivouac areas, office buildings, parking areas and garages. The third phase concentrated on assessing the extent of lead contamination in the production facilities and administration areas (18, 30). A total of 5700 TNT screening samples were collected. More than 1900 soil samples were collected for detailed analyses (18, 30).

RI sampling and analytical activities were conducted for WSTA in 1988 and 1989. RI sampling and analyses were conducted for the remainder of the non-DOE controlled WSOW in 1990 and 1991 (3). During these RI sampling and analysis activities, the primary contaminants discovered were nitroaromatics (2,4,6-TNT, 2,4-DNT, 2,6-DNT, 1,3,5-TNB, and 1,3-DNB), metals, including lead and arsenic, Polychlorinated Biphenyls (PCBs)s, polycyclic aromatic hydrocarbons (PAHs) and asbestos. All soil contaminants appear to be residual contamination from the production or disposal activities. Contaminants are generally limited to the surface and shallow subsurface. The exception to this is the extensive wooden pipeline constructed to transport wastewater to treatment plants (3, 18, 30). Although explosives contaminants were not found in soil samples surveys from pipeline locations, it is anticipated that such contamination will be found during remedial excavation (3).

Surface Soil

Access to contaminated areas onsite is limited to government and contractor personnel involved in remediation-related activities. Occupational Safety and Health Administration (OSHA) and EPA regulations require that remediation workers follow strict safety procedures at NPL sites. It is expected that remediation workers will follow required safety procedures thereby preventing exposure to contaminants during their activities. The U.S. Army Reserve maintains a training program on WSTA. Training activities are currently limited to 200 acres located away from contaminated sites. As areas are determined to be free of contamination,

it is anticipated that additional areas will be added for training (36). The remaining possible receptor population would be trespassers who ignore safety measures at WSTA. Exposure of trespassers to these soil contaminants is expected to be infrequent and short-term.

As stated above, access to WSTA is restricted to authorized personnel. The site is fenced to prevent trespassing. For these reasons, contact with environmental media onsite is limited primarily to remediation workers, and secondarily to trespassers who ignore and evade the security and warning measures. Based on information reviewed to date, health risks from nitroaromatics and other contaminants in the onsite soil are minimal. In the conservation areas, soil contamination is concentrated in the burning grounds which are fenced. Contact with contaminated soil in these areas is limited to infrequent incidental contact by trespassers. Health risks associated with incidental contact with contaminated soil in these areas is also regarded as minimal.

The Proposed Plan for remediation for Operable Unit One at WSOW envisions incineration for treatment for much of the soil contamination at the site. Incineration is a remedial alternative which is a concern to members of the public in terms of its safety. ATSDR will review the proposed plans for the remedial alternative chosen. Appendix D presents the ATSDR preliminary evaluation of the incineration alternative.

- Nitroaromatics

Surface soil in production and storage areas is contaminated primarily with nitroaromatics and metals. There are also multiple areas where discarded TNT was burned. Residue from this activity remains in the soil in these areas. Figure 8 shows the location of the various contaminated areas within WSTA (18, 30).

Surface soil samples collected during Remedial Investigation TNT screening surveys in the vicinity of the production plants showed widespread 2,4,6-TNT contamination with concentrations ranging as high as 63,621 mg/kg. The higher concentrations found were associated with the grainer houses and settling tanks. Sampling for other nitroaromatics found more moderate levels of DNT (maximum of 160.0 mg/kg for 2,4-DNT and 8.1 mg/kg for 2,6-DNT), associated with the wash house and grainer house areas. The maximum 1,3,5-TNB (trinitrobenzene) concentration was detected in wash house settling tanks areas at 130.0 mg/kg (18, 30).

The detected levels of 2,4,6-TNT far exceed any ATSDR comparison values (CVs) for soil (20.0 ppm - ATSDR Cancer Risk Evaluation Guides, or "CREG"). The detected levels of 1,3,5-TNB also exceed ATSDR soil CVs (40.0 ppm - ATSDR adult Reference Media Evaluation Guide, or "RMEG"). The levels of 2,4-DNT, 2,6-DNT are below the ATSDR soil CVs for adults (1,000 ppm - ATSDR adult chronic Environmental Media Evaluation

Guides, or "EMEG"; and 1,000 ppm - adult RMEG). It must be noted that the comparison values used are extremely conservative and protective of health, in that they are based on the assumption of long-term exposure. The exposures which would occur as described above are short-term and infrequent.

- Metals

Heavy metals and common metals are present throughout the nitration houses and wash houses. Arsenic, cadmium, zinc and thallium were detected above background. However, none were detected at concentrations of concern.

Lead was detected in thirteen of the nitration houses, ranging to 7300 mg/kg. The lead is believed to be residual product of acid reaction with the spark proof lead flooring and cladding used in many of the production facilities. Lead contamination at these levels is an issue in terms of chronic, repeated exposure (20). However, the fencing and warning signs in place at WSTA are sufficient to prevent access by the general public to the areas with lead-contaminated soils. As a result, the lead contaminated soil in these areas is not considered a threat to public health, based on current land use.

- Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) were detected in three of the nitration houses, three wash houses, and a waste water treatment area. The maximum concentration for PCBs was 42.0 ppm, in the waste water treatment area. The ATSDR CV for PCBs is 0.09 ppm, based on the ATSDR CREG derived from the EPA cancer slope factor. (The EPA slope factor is a numerical value used in estimating cancer risks in humans.) Exposures which might cause significant negative health effects would need to be greater than the infrequent and incidental exposures which trespassers may experience at WSTA. Therefore, exposures of trespassers to the concentrations of PCBs in soil are not of public health concern, and are not expected to result in adverse health effects.

- Asbestos

Asbestos was observed on the surface of the burning ground and in derelict and razed building sites (1). Surveys were made of numerous sites and the suspected presence of asbestos was noted in a number of derelict structures. No concentrations were presented in RI material. However, within the restricted areas of WSTA, there may be concentrations of asbestos that are health hazards to individuals who may be directly exposed, such as trespassers.

- Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) were also detected in low levels in numerous samples associated with the wash house areas (See Appendix C). Because of the expected infrequency of exposure at WSTA, the acute exposure is the only potential hazard. PAHs generally have low acute toxicity to humans. The CVs which were exceeded in onsite soils are those relating to cancer risk from life-time exposures. Additionally, adverse noncancer health effects associated with non-occupational (short-term, incidental) PAH exposure generally have not been observed in people. Therefore, exposures of trespassers to PAHs in soil are not expected to result in adverse health effects and for this reason are not of public health concern (22).

- Semi-Volatile Organics

Several semi-volatile organics (SVOCs) were found in low concentrations in samples from various areas associated with the production facilities. These contaminants (bis(2-ethylhexyl)phthalate, 1,2-dicarboxylic acid, dibutyl ester (dibutyl phthalate), N-nitrosodiphenylamine) were generally at or below detection levels. The SVOC contaminants were identified in the RI as laboratory contaminants and, as such, are obviously not considered a threat to public health.

Groundwater

The first evaluation of the extent of groundwater contamination was made by Fishel and Williams (1944) (28). Contamination of the groundwater was discovered to be widespread under WSTA and in the surrounding vicinity. Later environmental assessments during the 1950s and 1960s determined that the groundwater in the vicinity of WSTA was still contaminated, but no groundwater quality information was obtained (33). Since the start-up of WSOW and continuing today, drinking water for WSTA has been obtained from what is currently the county well field, located adjacent to the Missouri river south of WSTA. This well field is strongly influenced by water infiltrating from the river. From the well field, the water passes through the county water treatment facility before being distributed to local users, including WSTA (29). Historically, the use of groundwater for consumption on WSTA has been prohibited, and there are no production wells, so that groundwater contamination is not considered a public health threat.

A total of 34 wells in 20 locations within WSTA were constructed to perform the RI sampling activities. Samples were collected from the overburden and shallow bedrock

aquifer. As stated in sections above, the delineation of discrete contaminant plumes is precluded by the karstic nature of the aquifers. Sampling and analyses serve to determine the existence of groundwater contamination in the aquifers underlying WSTA and to define the range of concentrations present.

Contaminants associated with the production processes at WSOW were detected in the overburden and in two zones within the shallow bedrock aquifer. Nitroaromatics were detected frequently in the overburden and shallow bedrock aquifers. 2,4,6 TNT was observed at levels ranging up to 51 ppb (31). 2,4 DNT and 2,6 DNT ranged from 0.75 to 69.0 ppb (31). 1,3,5 TNB ranged from 0.75 to 7.3 ppb. The higher concentrations were generally found in the overburden wells. Lower levels and less frequent detections were recorded for the deeper zone of the shallow bedrock aquifer. Cadmium was also detected at levels above EPA's Maximum Contaminant Level (MCL) in samples from all three zones. Cadmium, was also detected at levels above ATSDR CVs. Appendix F presents a summary of the WSTA groundwater contaminants which exceeded ATSDR CVs. Institutional controls enacted by the Army prohibit the use of groundwater on WSTA, so that at present, there are no receptor populations for these contaminants. Offsite wells were sampled as a part of the RI process. Maximum cadmium levels in these wells (0.3 ppb) did not exceed ATSDR CVs (18, 30). Monitoring programs for the St. Charles County Wellfield are in place to monitor for hazardous chemicals (including military-specific compounds) in that water supply (32).

Physical Hazards

TNT and DNT are comparatively insensitive to physical shock, and can even be burned in small quantities without danger of detonation. As a result of these characteristics, it is unlikely that TNT or DNT contaminated soils represent a physical hazard. However, high levels of contamination in large quantities are present in the WSTA wooden sewer pipe system. By-product wastes were piped through 83,300 feet of wooden sewer pipe. During the early production period wastewater was stored in lagoons (3). The pipelines are contaminated with encrusted nitroaromatics in large enough quantities to represent a risk of explosion if they were to be improperly disturbed during remediation.

Additional physical hazards onsite include derelict structures, foundations, basements and cisterns. These derelict structures should be considered to be physical hazards, primarily to site remediation workers. Derelict structures which remain in troop training areas may be considered physical hazards to troops engaged in training on WSTA. It should be noted, however, that the training and missions of both remediation workers and military personnel are such that they are likely to both be aware of these types of hazards and prepared to deal with them. Access to WSTA is restricted to authorized personnel, so that the only members of the public exposed to possible physical hazards would be trespassers. In the case of trespassers, warning signs and fencing are in place to restrict access to protect the public

from contact with these and other hazards. Although specific plans are not detailed, the WSOW Final Feasibility Study (FS) mentions clearing of these potential hazards as a part of the remediation process (6).

Conservation Areas

As stated previously, "the conservation areas" in this document are defined as portions of the original ordnance production facility not now controlled by the Army or DOE. Visitors to the conservation areas are the most likely people to be exposed in the these portions of former WSOW. As the following information shows, the possibility for a completed pathway is extremely limited in the conservation areas. Additionally, visitors are usually in these areas infrequently and generally for only a short period of time, so that any exposures which might occur would be limited.

A number of the remaining structures in the former WSOW outside DOD and DOE controlled areas are currently operated by MDOC and St. Charles County Water Department. No contaminants were detected in RI analyses from samples taken in the vicinity of these structures (See Figure 6)(1).

There are also a number of derelict structures remaining on conservation areas. The majority of these are former storage bunkers, located in the Busch Area. The three production areas outside the Army and DOE areas were dismantled and the foundations covered with soil to eliminate physical hazards (1).

Mechanical City, the construction and maintenance center for WSOW is located just south of WSTA. The area once contained 10 buildings. These have been demolished, leaving only foundations and fire hydrants. A large amount of construction debris remains in this area (1).

Several former disposal facilities for WSOW are located outside the present boundaries of DOD and DOE controlled areas. These include six burning grounds, three wastewater lagoons, and a dump. The dump is not a formal WSOW disposal area, but reportedly contains a small amount of construction debris. The burning grounds show variable amounts of burned debris. Lagoon 7 (Lake 16) is currently filled with water and is used for catch and release fishing. Lagoon 6 is seasonally filled with ponded water and is not frequently used for recreational purposes.

Springs sampled within WSOW have been shown to be contaminated with nitroaromatics. However, groundwater and groundwater-fed springs are not used as a drinking water source for the conservation areas. Contact with contaminated spring water is a possible pathway of

concern, although such contact is not a frequent occurrence. Institutional controls placed on groundwater use in the conservation areas have eliminated it as a source for drinking water, so that at present groundwater does not represent a completed pathway.

Access to soil-contaminated areas in the WSOW is restricted. Contaminated areas are fenced, posted. Maps delineating contaminated areas on conservation lands are available at the Conservation Area Information Center.

One possible pathway to be evaluated is the former explosives wastewater lagoon #7, which is now a stocked fishing pond on the August Busch Memorial Conservation Area. For fisheries management purposes, the state of Missouri has placed catch-and-release restrictions on use of this lake, effectively minimizing exposure through the consumption of any potentially contaminated fish from this source.

Consumption of contaminated game is a very limited issue in the conservation areas. Contamination of soil and surface water is very limited and the potential for exposure of game animals is also very limited. However, since there is even the limited potential that these animals may be exposed to contamination within WSTA and then could move into the conservation areas and offsite, this document evaluates this potential pathway. Also, some degree of bioaccumulation in game animals could occur through consumption of onsite contaminated water. However, the most contaminated areas are not vegetated and are not attractive grazing areas. Therefore it is not likely that they would be sources of exposure for deer. Limited evaluations have been made regarding contamination of fish and game at WSOW. However, more detailed work at similar sites is available for comparison. This information is discussed in later sections.

Surface Soil

The existence of former production, storage and waste disposal facilities within WSOW but outside the Army and DOE controlled areas (See Figure 6) necessitated extensive environmental sampling and analyses in the former WSOW. Access to these areas is restricted by fencing and therefore contact is unlikely. Contamination localized in these areas has been documented in RI sampling and analytical activities. Similar to WSTA, the contaminants of interest are nitroaromatics and metals. The following sections summarize the evaluation of data collected from specified areas.

- Nitroaromatics

More than 2100 surface soil samples were collected and analyzed during TNT screening activities. Sampling activities were concentrated on the burning grounds, around bunkers and

at former sites of the three regraining facilities. A detection limit of 5.0 ppm was established for these samples (1). ATSDR has established a CREG comparison value for TNT of 20.0 ppm based on EPA lifetime cancer risk slope factor calculations. The ATSDR EMEG for ingestion of soil by a child is 30 ppm. This comparison value accounts for daily human exposure to a chemical that is likely to be without noncarcinogenic effects over a specified duration of exposure to include acute, intermediate, and chronic exposures. Based on these criteria, the 5.0 ppm detection limit should be sufficient to detect TNT concentrations which might be a human health threat. The WSOW RI depicted the screening test results in incremental categories of <5 ppm, 5 to 10 ppm, 11 to 100 ppm 101 to 1000 ppm and >1000 ppm. For the purposes of this evaluation any detections in the 11 to 100 ppm range or greater are considered to be of possible concern.

The burning grounds were the only facilities screened in which contaminants were found. Many of the detections were sufficiently high to be of concern. Figure 9 depicts the locations of the burning grounds. Burning ground 1, with a total of 200 samples collected had 30 samples with TNT concentrations of 11.0 ppm or greater. The highest concentration was 510,632 ppm. Burning ground 2, with 170 total samples, had five samples with greater than 11.0 ppm TNT. The maximum concentration was 3,513 ppm. Burning ground 3, with 146 total samples, had seven samples above 11.0 ppm TNT. Here, the maximum concentration for TNT was 2,966 ppm. Burning ground 4 had 25 samples, with none exceeding 11 ppm. Burning ground 7, with 110 samples collected, had eight which exceeded 11 ppm. The maximum concentration in this area was 11,414 ppm of TNT. Burning ground 8 had 72 samples collected, with none above the detection limit. The dump had a total of 106 samples collected, with one in excess of 11 ppm TNT concentration. That sample measured a TNT concentration of 30 ppm (1).

At present, institutional controls in the form of fencing and warning signs restrict public access to the burning grounds, and serve to prevent exposure to any members of the public except for determined trespassers. Burning ground 1 presents the most substantial risk both in terms of the number of detections at levels of concern, and in terms of the high concentrations of TNT present. Burning ground 1 also contained one sample in which 2,4 DNT was measured at a concentration of 7,100 ppm, well above the ATSDR comparison values. The remaining three areas, burning grounds 2,3, and 7 had proportionally fewer samples in excess of levels of concern. However, the maximum concentrations were high enough that these areas should be evaluated to determine the extent of the hotspots.

- Metals

The metals sampled for during WSOW RI activities are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. As with nitroaromatics, sampling activities concentrated on the areas surrounding former WSOW facilities (1). Lead was the single

metal detected at levels of concern. ATSDR is currently using a level of 500 ppm as the comparison value (CV) for lead in soils (20). Isolated soil samples at bunkers designated B24-03 and B50-3 exceeded the ATSDR CV (667 and 949 ppm, respectively) (1). These samples were collected from small areas (about one foot in radius) surrounding drains at these bunkers. The drain lines originate inside the bunkers, and serve to collect seepwater and condensation from the bunkers. The source of the lead is unknown, but it is believed to be from accumulations of trash and debris as well as expended recreational firearm rounds (21). Samples collected from burning ground 1 exceeded the ATSDR CV in several instances. Where concentrations exceed 500 ppm, the EPA Proposed Plan for Soils calls for stabilization and landfilling (31).

Groundwater

The karstic nature of the subsurface geology is such that it is not possible to trace groundwater contaminant plumes off of WSTA with any accuracy. However, in general terms, groundwater flow can be roughly correlated to surface water drainages. The surface water drainage divide runs approximately east-west through the center of WSOW. In the northern half, surface water flows north. In the southern portion of the site, the flow is generally to the south. Detection of low levels of nitroaromatic contaminants are seen in analyses of groundwater within the WSOW boundaries (10). The levels found are below ATSDR CVs. Additionally, as is the case with WSTA, drinking water has been and is currently supplied by the St. Charles County Wellfield, so that consumption of contaminated groundwater is not generally a concern.

Springs sampled within the former WSOW have been shown to be contaminated with nitroaromatics, although at concentrations generally below ATSDR comparison values (18, 30). Contact with contaminated spring water is a possible pathway of concern, although such contact is not a frequent occurrence.

Isolated springs were sampled during the spring of 1989 in which 2,4,6 TNT exceeded ATSDR CREG CV of 1.0 ppb. The five springs had 2,4,6 TNT concentrations ranging from 1.6 to 3.0 ppb. Concentrations of contaminants detected during low flow periods did not exceed ATSDR CVs (18, 30). The EPA has issued a Health Advisory for TNT. The recommended drinking water equivalent level for the per-day lifetime (70 year) exposure for a 10 kilogram child is 0.02 mg/L, or 20 ppb (19). In view of the low probability that people would drink the water from these springs, and the greater improbability that any one person would frequently drink this water, these springs should not be considered a threat to human health.

Biota/Foodchain

Land-use restrictions and health and safety requirements for site workers have minimized the potential for human exposure to contaminants onsite. However, under current conditions, biota may be exposed to contamination in soils, sediments, and surface water. Although access by the general public to WSTA is restricted, it is possible for game and waterfowl to move through contaminated onsite areas as part of their ranging territories. Game animals may consume site-related contaminants through ingestion of contaminated soil, plant material that has taken up contaminants from the soil, from ingestion of contaminated surface water, and possibly, from contaminated dust on forage. Additionally, fish may be exposed to and take up contaminants from affected surface water or sediment.

Comprehensive game and fish take information is not currently available for the Busch Conservation Area. However, such information is available for the adjacent Weldon Spring Conservation Area. If the per-person usage is similar between the two areas, assumptions can be made concerning the numbers of game and fish collected by the public.

The Missouri Department of Conservation estimates that, based on surveys, in a one-year period of 1989-1990 558 squirrels, 283 rabbits, 89 deer, 93 doves, 146 ducks, 8 quail and 1 turkey were taken by hunters from the Weldon Spring Conservation Area. Weldon Spring anglers kept a total of 7,232 fish. Of this total there were 2,702 catfish, 1,970 buffalo, 722 freshwater drum, and 527 bluegill. The remainder were carp, largemouth bass, crappie, walleye, striped bass, and sunfish. According to the Missouri Department of Conservation, these fish were caught by a total of 3,603 anglers (26). Creel surveys are available for Lakes 34 and 35 at Busch Conservation Areas. The 1993 survey of Lake 34 depict a similar diversity of species, with a total of 2,871 fish, caught and kept by 4,686 anglers. The total estimated weight of these fish is 1,380 pounds (lbs), or approximately 0.29 lbs per angler. The 1992 survey for Lake 35 estimated a total of 5,376 fish caught by 9,186 anglers. The total weight of this catch is estimated at 2,316 lbs. The average weight of catch per angler for this lake is about 0.25 lbs (25). It is probable that these totals are representative of the catches that occur at other lakes in this area, and that the average amount of fish per angler is similar for the other fishing lakes. What is implied from this information and from informal observations by state officials (27), is that there is little or no subsistence fishing occurring in the conservation areas. Therefore, fish from these lakes are apparently not consumed by the public on a regular and frequent basis.

Food chain exposure pathways include the consumption of animals that have been exposed to and could have bioaccumulated contaminants. Chemicals such as metals can accumulate in tissues of certain organisms at levels higher than the chemicals' concentrations in water, sediment, soil, or vegetation. An evaluation of the effect on fish and game is important, since, as the following information suggests, exposure of biota to contaminants may be occurring.

- Fish

Low levels of explosives contamination have been documented for several surface water bodies in the Busch and Weldon Spring Conservation Areas (1). Contaminant levels are depicted in Table 2.

Water samples were collected from 18 lakes and two (former) lagoons in the conservation areas. Sediment samples and/or cores were collected from each of the lakes and three lagoons (#1, #6, and #7). Of the 18 lakes sampled, six (Lakes 10, 23, 32, 35, 36) had detectable levels of nitroaromatics in surface water (1). Detections are listed in Table 2. Lakes in which no nitroaromatic contaminants were found include; 2, 4, 7, 8, 10, 20-22, 24, 32-34, and the unnamed lake south of Hampton Lake. Locations of the conservation area lakes and lagoons are shown in Figure 10.

Lagoon 6 was the only one of the lagoons with water samples that had detectable levels of nitroaromatics (0.07 ppb o-nitrotoluene). No nitroaromatic contaminants were detected in lagoon 7 (Lake 16). Sediment sample analyses revealed no nitroaromatics at the detection levels (1). Numerous metals were detected in sediments at varying levels. Lake 4 had the only water sample in which state of Missouri drinking water standards were exceeded. The metal of concern in Lake 4 was selenium, with a concentration of 0.11 ppm. Of sediment samples, only Lake 16 had metals in excess of state sediment standards (arsenic at 0.053 ppm) (1). Additionally, sediment samples collected from streams exiting WSTA documented very low, localized concentrations of nitroaromatics, metals and SVOCs(18, 30). The contaminant levels found are well below levels which might be of concern in terms of human consumption or contact.

Although exposure via consumption of surface water is not a threat, the effect of these levels of contaminants on fish is a concern expressed by the public (See Community Health Concerns section). Consumption of nitroaromatic-contaminated fish is a concern if the fish contain relatively high levels of contaminant or as the result of long periods of frequent consumption of contaminated fish. Studies have been conducted to determine the extent to which fish bioconcentrate nitroaromatic contaminants (41,42). From these studies, it is possible to use the levels of contaminants found in water to roughly estimate the amount of fish which would have to be consumed to pose a potential threat. At the levels of contaminants found in the area lakes, using the most protective assumptions, it is projected that consumption of contaminated fish would have to occur on a daily basis for a period of years (43). To date, fish taken from these lakes have not been analyzed for nitroaromatics contamination. However, based on the low levels of nitroaromatic contaminants detected in water it is unlikely that fish would be contaminated at levels of concern.

In 1988 DOE contractors collected fish from lakes 34-36 in the Busch Conservation Area, and lake 37, an offsite lake considered to represent background. Whole, cleaned fish (scaled, beheaded and eviscerated) and fillets were composited and analyzed. These samples were prepared to represent the edible portions of the species collected. These samples were then analyzed for metals.

The analyses were reviewed by ATSDR in 1989. ATSDR Emergency Response Branch wrote a health consultation at the request of EPA Region VII on "Fish Data, Weldon Spring Site, St. Charles County, Missouri" (45). The consultation evaluated the potential public health hazard of contaminants present in the composite fish samples. Metals of concern were mercury, lead and arsenic. Mercury was detected in fish samples from all four lakes at levels ranging from 0.16 to 0.27 ug/g (ppm). Fish from lake 37 contained 0.23 ug/g of mercury. Lead was found in fish at 4.0 ug/g in lake 34 and 4.2 ug/g in lake 36. Arsenic was detected in fish at 13.9 ug/g in lake 35 and 13.6 ug/g in lake 37.

Lead in fish taken from lakes 34 and 36 presents an increased potential for adverse lead exposure to children and pregnant women who regularly and frequently consume the contaminated fish. However, the lead in these composite fish samples is not a public health threat to area residents who have occasional fish meals from locally caught fish. Arsenic found in fish is usually in an essentially nontoxic, organic form. Without speciating the metals it is not possible to determine conclusively the toxicity of the arsenic in these fish. In any event, the possible adverse effect would be greatly reduced if consumption of fish from this lake is limited.

EPA contractors collected and analyzed additional fish samples from Lake 36 in June and November of 1992 (46). Whole fish and fillet samples were analyzed for lead, mercury and arsenic, with detection limits of 0.1 mg/kg (ppm). Arsenic was not detected. Lead was detected in whole fish samples at a maximum concentration of 0.176 mg/kg. Mercury was detected in fillet samples at a maximum concentration of 0.212 mg/kg. The lead level is noticeably lower than those detected in the 1988 study. The level for mercury was similar to those found in the 1988 study. ATSDR evaluated the results of this study in 1993. The consultation concluded that these levels were not a concern for either infrequent or subsistence consumption (49). Additionally, the MDOH considers lead levels above 0.3 ppm to justify a no-consumption fishing advisory. Based on the decrease in lead levels from the 1988 analyses to the 1992 analyses, the MDOH does not feel that an advisory is necessary for these lakes (50).

- Game

Little information has been collected regarding bioaccumulation of contaminants in animals commonly hunted in the conservation areas. However, a 1988 study by DOE contractors did

evaluate the possible extent of radionuclide and metal contamination in squirrels and rabbits (9). Analyses of these samples found no significant accumulation of contaminants (9). This and subsequent DOE studies will be evaluated in the public health assessment being completed for the DOE site. As stated earlier, the areas heavily contaminated by nitroaromatics are not vegetated and are not attractive to grazing animals. For this reason, the opportunity for exposure to game animals is lessened.

A recent study, undertaken by the U.S. Army Environmental Hygiene Agency at the Joliet Army Ammunition Plant, Wills County Illinois, evaluated the bioaccumulation of chemical contaminants in deer (38). This study focused on explosives contaminants present at a munitions production facility and is therefore useful in the assessment of the effect on these contaminants at WSOW. Contaminants of concern in the Joliet study were; metals, PCBs, and explosives, including TNT, DNT, DNB and TNB. Concentrations of these chemicals in environmental media varied widely across the site. However, because of the similarity of production facilities and products, the ranges of concentrations found at Joliet were comparable with those found at WSTA.

Samples were collected of deer muscle, liver, kidney, bone and fat. The study found that there did not appear to be any appreciable bioaccumulation of nitroaromatics in these tissues. There was, however, an accumulation of low levels of arsenic thought to come from natural background levels in the soil.

The Joliet study also cited two other Army studies on bioaccumulation of nitroaromatics in game animals. Evaluations were performed on samples collected at the Alabama Army Ammunition Plant, Childersburg, Alabama (40), and the Badger Army Ammunition Plant, Baraboo, Wisconsin (44).

The study conducted at the Alabama facility assessed the bioaccumulation of TNT in deer, rabbit and quail. It was found that TNT did not accumulate at a level above the 0.2 mg/kg detection level (40). The study conducted at the Wisconsin facility assessed bioaccumulation of DNT in deer tissue. It was found that DNT did not accumulate in the animals sampled above the 0.1 mg/kg detection level (44). For comparison, ATSDR CVs for TNT, 2,4-DNT, and 2,6-DNT in drinking water are 1.0 mg/kg, 20.0 mg/kg, and 400.0 mg/kg. Based on the information provided by these three studies, and assuming that former explosives production are similar in their relevant characteristics, consumption of game animals from the conservation areas is not a public health threat.

Physical Hazards

A number of derelict structures remain on the former WSOW outside Army and DOE controlled areas. The majority of the remaining structures are former storage bunkers,

located in the Busch Area. Of the 100 total bunkers existing on the site, nine are used by the state for storage and are locked. A total of 76 of the bunkers are empty and have been sealed by the state. Fifteen remain open but are empty.

Additionally, a large amount of construction debris was found in Mechanical City, the construction and maintenance center for the former WSOW located just south of WSTA. Although it is recognized that the general public seldom visits the southern portion of the former WSOW, this debris may still constitute a physical hazard.

Offsite

The primary concern regarding contaminants emanating from the WSTA is that of groundwater contamination. The following is an evaluation of the probable extent of contamination in this medium.

Groundwater

The predominant source of drinking water for the residents in the vicinity is the St. Charles County Wellfield, located in the Missouri River floodplain to the south of WSTA. Water is obtained from Missouri River alluvium and from the bedrock aquifers. Based on the proximity of the wellfield to the Missouri, a major source of water is infiltration from the river. Residents to the northeast of the former WSOW receive water from St. Charles County Water Supply District #2.

The karstic nature of the subsurface geology is such that it is not possible to trace groundwater contaminant plumes into offsite areas with any accuracy. However, as stated earlier across the northern portion of the WSOW and adjacent area, surface water flows north. In the southern area, the flow is generally to the south. RI environmental sampling and analysis document that contaminants in trace amounts in groundwater have migrated offsite as described below.

According to information provided by army and state investigations, the only location where any occurrence of explosives contaminants has been found in drinking water is the Twin Island Lake Resort (4, 18, 30, 13, 34, 35). Established in the 1950's, today the resort has about 175 trailer campsites and about 50 sites for tent camping. About half of the trailer sites are occupied year round. The average daily population at the resort varies for about 250 to about 675 over the course of a year. A fishing lake is supplied by springs within the lake (4). In 1988, five of the six wells at the resort were found to be contaminated with

explosives (see Table 4). Until 1989, drinking water, as well as water for the swimming lake, were provided by groundwater wells. There was no treatment for any of the water sources. People were exposed to very low levels of explosives via ingestion, inhalation and dermal contact with contaminated well water. The duration of exposure is unknown. The well water was not tested for nitroaromatics until the state of Missouri developed the technology and procedures for accurate testing in 1988. As a precaution to protect the health of resort visitors, the COE began providing drinking water in 1989. In April of 1991, water lines were installed and water is currently provided by the local water district. Subsequent to the initial sampling for nitroaromatics in 1988, nitroaromatic contaminants have not been detected (10). Table 3 summarizes the groundwater usage at Twin Island Lake Resort.

The state of Missouri tested the Twin Island Lake wells for explosives in 1988. The Kansas City District Army COE sampled in 1989. Five of the six wells used for drinking water were sampled. The state of Missouri sampling revealed trace levels of 2,4-DNT and 0.17 - 0.19 ppb of 2,6-DNT, well below the ATSDR CV. COE sampling revealed explosives contaminants in 3 of 4 wells sampled (4). See Table 4 for a summary of the analyses. ATSDR comparison values were exceeded in samples from Wells #1, #3 and #61 for 1,3,5-TNB. Well #3 is the supply well located closest to Weldon Spring. Wells #1 and #61 are connected and located adjacent to each other north of #3, on the western portion of the resort. The levels of TNB found in these wells during this sampling round exceed ATSDR's RMEG CV of 0.5 ppb. The RMEG is derived by ATSDR from the EPA oral Reference Dose. It is a very conservative estimate of the concentration in water or soil at which daily **long-term** human exposure is unlikely to result in adverse noncancerous effects. Additional discussion of the health effects of TNB can be found in Appendix E.

In 1989 the drinking water pathway was eliminated when the resort began receiving bottled water from the U.S. Army. The resort is currently supplied by a water line from the St. Charles County Public Water Supply District #2, installed by the Army in April of 1991 (36). More recent sampling has not detected the presence of nitroaromatic contaminants in these wells (10). Additionally, incidental dermal contact and inhalation of water from the swimming lake and goldfish pond is not a problem, since no contaminants have been detected in recent sampling.

Thus far, no other occurrence of nitroaromatics have been found in any other drinking water wells in the vicinity of WSOW. The Missouri Department of Health continued to monitor private wells for nitroaromatics until 1992. Since that time wells have been monitored on a quarterly basis for other contaminants, with the emphasis being on radionuclides from the DOE sites and on metals (13, 34). No contaminants have been detected at levels of concern. These data will be thoroughly evaluated in the public health assessment being completed for the DOE facilities at Weldon Spring. The St. Charles County Water Department monitors municipal wells south of the Quarry for site-related contaminants (37).

Quality Assurance and Quality Control (QA/QC)

The contaminant values recorded in this public health assessment are based upon the data developed for and provided by the Department of the Army and the EPA. The most recent RI reports (1,18, 30) describe quality assurance/control measures consistent with usual and acceptable standards in effect at the time the reports were prepared. Documents prepared by EPA, the Department of the Army or their agents reflect, as stated or implied, such standards and practices.

Sampling and analytical procedures used by the state of Missouri followed EPA Contract Laboratory Procedures (CLP) requirements (39). The data provided by state of Missouri also meets acceptable quality control standards and practices.

PUBLIC HEALTH IMPLICATIONS

Toxicological Evaluation

A person is exposed to a contaminant only if the person breathes, eats, or drinks a substance containing the contaminant or by skin contact with a substance containing the contaminant. Several factors determine the health effects of an exposure. These factors include the concentration of the contaminant, the frequency or duration of exposure, the route or pathway of exposure, and the possibility of exposure to a combination of contaminants. Once exposure takes place, characteristics such as age, sex, nutritional status, genetics, lifestyle, and health status influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. The combination of these factors determines the health effects that could result. Once these factors have been evaluated, it is possible to decide whether there is truly a completed environmental pathway which could result in significant public health concern.

No current completed pathways have been found for contaminants resulting from past ordnance production at the former WSOW. No evidence exists of any public health problems from any potential past exposures. Although exposure levels prior to 1988 can not be determined, the nitroaromatics detected in the Twin Island Lake wells were not at levels high enough to present a hazard to public health. However, for information purposes Appendix E provides brief toxicological evaluations of the contaminants discussed.

Health Outcome Data

Health outcome data (HOD) document health effects that occur in populations. The data can provide information on the general health status of the community living near a hazardous waste site. It can also provide information on patterns of specified outcomes. Some examples of health outcome databases are tumor registries, birth defects registries, and vital statistics.

Because of the likelihood that no exposures occurred, and since the contaminants resulting from ordnance production are not likely to cause leukemia, extensive review of these data would not provide useful information for this health assessment. However, based on the concern expressed by local members of the public about leukemia incidence, information provided by the Missouri Department of Health was reviewed (14,15). This information indicated that total childhood leukemia incidence and mortality rates for St. Charles County are not significantly elevated relative to state-wide rates. This issue is discussed in more detail in the "Community Health Concerns" section of this document. ATSDR-supported

investigations of hospital release data and mortality records for the area have not revealed any health problems which could be related to either of the Weldon Spring sites (16). As a part of the public health assessment for the DOE facilities, additional evaluations will be made of health outcome data to further define occurrence of specific cancer incidence.

Community Health Concerns

The following concerns have been identified by ATSDR through meetings, correspondence, and telephone conversations. The sources of these concerns include citizen groups, governmental agencies, and individual residents. Concerns include those which relate to the specifically to the Army NPL site or which may be overall concerns related to both NPL sites. Concerns specifically related to the DOE portion of the Weldon Spring facilities are not addressed here, but will be addressed in a separate public health assessment. The following concerns are not listed in any order of frequency or significance.

- **Past and current exposure to areas of WSOW outside WSTA soil contamination by hunters, campers, and hikers in the adjacent conservation areas;**

  As summarized in the Environmental Contamination section above, offsite soil contamination is not a serious hazard to visitors to the conservation areas. Soil sampling and analyses have confirmed that contamination at levels of concern in the conservation areas are limited to fenced areas that are not accessible to visitors to the recreation areas. During the soil surveys, TNT was reported in several of the samples collected in the bunker areas. Isolated samples from the Busch area and in the vicinity of the school/box factory were also found to have low levels of TNT contamination (1). In all cases these, detections do not represent contamination at levels which would be a threat to public health.

- **Ingestion of contaminants that have bioaccumulated in fish and game from the conservation areas and the Little Femme Osage Slough;**

  This issue is addressed in some detail in this document. The reported and projected contaminant levels in fish from the conservation areas is low enough that occasional consumption should not be considered a public health hazard. Currently, water and fish sample analyses information for Little Femme Osage does not exist. DOE is undertaking an analysis at present. Information from this analysis will be incorporated in the upcoming public health assessment addressing the DOE facilities. Additionally, ATSDR is recommending that additional fish samples be collected for analysis of metals contamination.

- **Contamination of private wells by toxic substances migrating from the Weldon Spring Training Area and Chemical Plant Sites;**

  The only offsite wells that have been documented to be affected are those at the Twin Island Lake Resort. The wells in the resort are only minimally affected and public water is provided as an additional safety measure. Current monitoring by the state of Missouri did not reveal the presence of contaminants at levels high enough to be considered a public health hazard. The most recent sampling has not detected nitroaromatics in well water at Twin Island Lake Resort.

- **Potential releases of toxic substances from the Weldon Spring waste storage cell as a result of earthquakes or karst dissolution and collapse in underlying limestone terrain;**

  The CERCLA Feasibility Study (FS) describes the remedial procedures considered for a "Superfund" site (6). These procedures are subjected to critical engineering and environmental review to ensure suitability. The review process should include an examination of the suitability of these facilities based on the expected local and regional geological stability. RCRA hazardous waste landfill requirements specify that construction take into account the geologic character of the proposed site. At present the location has not been delineated for a landfill. ATSDR will review the documentation provided to evaluate the effect on public health that might occur as a result of the remedial activities. The geotechnical stability of any hazardous material landfill facility at WSOW will be a consideration.

- **Potential remedial worker exposures to asbestos and other hazardous materials due to insufficient worker training;**

  EPA requires that the remediation Health and Safety Plan assure that Occupational Safety and Health Administration (OSHA) regulations be followed for the protection of remedial workers. Remedial coordinators will be onsite to monitor remediation activities to assure that safety standards are followed.

- **Potential site hazards due to localized concentrations of explosives materials at the Former Ordnance Works;**

  This document addresses the concerns related to explosives contamination. Institutional controls have restricted (if not totally eliminated) access by the public to areas within the conservation areas and on the WSTA which have significant levels of contamination. Localized high concentrations are not a danger in terms of accidental detonation, since even the pure product is extremely insensitive to physical shock. The contamination in the waste system pipelines is a concern in terms of accidental

detonation only if improper removal techniques are used. Additionally, the Remedial Investigation provides extensive information regarding the locations of explosives materials at WSOW. With this information EPA, the Army and the state of Missouri provide measures which are protective against hazards posed by such contaminants.

- **Construction of an on-site incinerator to dispose of hazardous materials;**

  ATSDR will review the incineration activity plans to determine the extent to which these activities address protection of public health. Additionally, the EPA remedial process at NPL sites provides for the evaluation of remedial technologies being considered. At the time alternatives are presented, the opportunity is given to review and comment. During the operation of any chosen technology, monitoring activities are required by law to ensure that the process is safely conducted. ATSDR has reviewed the Feasibility Study and Proposed Plan for soil remediation procedures. This evaluation is provided in Appendix D of this document.

- **There is specific concern over the number of childhood leukemia cases in the Weldon Spring area;**

  In the "Report on Childhood Leukemia in St. Charles County (1970-1983)"(14), the Missouri Department of Health determined that there was no geographic clustering of leukemia in St. Charles County. The study did not find any environmental commonalities, such as water supplies, among the occurrences of leukemia. It is further noted that the reported cases did not appear to have any specific common cause or causes. In view of these findings, and since there have been no documented exposures, no causal link can be determined between contamination resulting from ordnance production activities at WSOW and the occurrences of childhood leukemia in the area. Further evaluation of leukemia will be conducted for the DOE facilities public health assessment.

  A fact sheet on St. Charles County Childhood Leukemia published by the Missouri Department of Health (April, 1994) indicated that total childhood leukemia incidence and mortality rates for St. Charles County are not significantly elevated relative to (or - "greater than") state-wide rates. ATSDR is currently conducting discussions with the Missouri Department of Health to conduct a comprehensive analysis of WSSRAP site-related contaminant distribution and occurrence of specific cancer incidence.

- **Some crops are grown on areas adjacent to site owned by University of Missouri and there is some concern that these crops may be contaminated by site-related hazardous materials and consumed by people;**

The crops in question are those in the conservation areas, planted largely for wildlife or livestock consumption. Soil contamination outside the restricted areas is not a problem. Additionally, groundwater is not used for irrigation of these crops, so contaminants would not be introduced by that means.

- **During the July 1994 Public Availability Sessions, the question was asked whether cases of childhood alopecia might be the result of exposure to chemical contaminants present at WSOW.**

  No completed exposure pathways to WSTA contaminants have been documented, including the area in which the alopecia occurred. Additionally, no causal links are known to exist between explosive ordnance chemicals and alopecia (47,48).

DOE Site-related Questions

Questions relating to contaminants potentially resulting from operations at the DOE facilities at Weldon Spring will be addressed in a separate public health assessment.

CONCLUSIONS

Weldon Spring Training Area (WSTA)

- Areas onsite have soil contaminants, predominantly nitroaromatics and lead, at levels of concern. Asbestos is also associated with derelict structures and at the site of razed buildings. Derelict structures still represent potential physical hazards. Access to these areas is controlled by fencing and institutional controls.

- Buried wastewater pipelines are physical hazards to remedial workers because there is the potential for explosion during excavation or handling operations.

- The OU-1 Record of Decision (not finalized at the time of publication of this document) describes incineration of contaminated soils as the preferred alternative described in the proposed plan for soil remediation. Incineration is probably the most effective way to destroy the TNT and DNT present. At present, insufficient information on the design, operation and location of the proposed incinerator is available to ATSDR to estimate whether impacts may occur in the local community. However, a properly designed and operated incinerator can be run in a manner that is protective of public health.

- Groundwater is contaminated under the WSTA. Institutional controls have eliminated the use of contaminated groundwater as a drinking water source.

Conservation Areas

- Derelict structures and disposal areas (including former burning grounds) exist in the conservation areas; however adequate institutional controls are in place to restrict public access.

- Little data is available concerning contamination of game and fish in the wildlife areas. However, there appears to be little likelihood that game animals are exposed to or ingest appreciable amounts of soil contaminants. Also, surface water and sediment contamination in the wildlife areas is at such low levels, in the few cases where contaminants have been detected, that significant exposure and uptake in fish is unlikely. For these reasons, consumption of game and fish collected from the wildlife areas is not a public health problem.

- Isolated springs within the conservation areas are contaminated with low levels of nitroaromatic contamination. The potential for frequent and regular consumption is

low, therefore it is unlikely that the public could be exposed to contaminants at levels of concern.

- Localized areas have soil contamination, predominantly nitroaromatics and lead. Access by the public to these areas is restricted by fencing.

Offsite

- Persons were exposed to small amounts of nitroaromatics in drinking water at the Twin Island Lakes Campground in the past. For the time period prior to 1988, levels of contamination and length of time of exposure were not documented, and it is not possible to estimate whether adverse health effects due to exposure were possible. However, in analyses from 1988 to the present, levels of contaminants found in this water were not high enough to be of health concern. The contaminated wells were taken out of service when the contaminants were detected. An alternate source of drinking water has been supplied.

RECOMMENDATIONS

The Comprehensive Environmental Response Compensation, and Liability Act (CERCLA; also known as Superfund) as amended, requires ATSDR to conduct needed follow-up health actions in communities living near hazardous waste sites. To identify appropriate actions, ATSDR created the Health Activities Recommendation Panel (HARP). HARP has evaluated the data and information contained in the Weldon Spring Ordnance Works - Weldon Spring Training Area Public Health Assessment for appropriate public health actions. HARP determined that health education and health studies follow-up actions are not warranted. As discussed above, there do not appear to have been exposures in the past which resulted in public health problems, and there are no current exposures.

Weldon Spring Training Area (WSTA)

- Nitroaromatic contamination is widespread throughout soil within WSTA. Access should be restricted to all areas with known contamination until remediation is completed.

- WSTA areas with physical hazards should continue to be evaluated for safety considerations prior to use in troop training activities. In cases where such hazards exist, commanders should be apprised of the locations of these hazards.

- The buried pipelines and other physical hazards should be removed using appropriate safety precautions.

- Asbestos contamination is widespread in and around derelict or razed structures. The hazard presented by this asbestos to people onsite should be thoroughly evaluated and mitigated. Proper abatement procedures should be used in soil remediation activities in the areas considered contaminated by asbestos.

- ATSDR will work with EPA to review and comment on design and operating conditions of the incinerator, during the remedial design process, to assure that the final conditions are protective of public health.

Conservation Areas

- Public awareness should be maintained regarding the very low levels of contamination present in fishing lakes in the vicinity of the sites. The state

should continue to educate the public, through its state-wide advisories, concerning any information available on contamination in fish. In light of the variation in results of the fish data existing for lakes 34, 35 and 36, ATSDR recommends that additional fish samples be collected to confirm that there is no current metals contamination. Metals analyses should be performed in fish collected from other heavily fished lakes.

- Since nitroaromatics are not a problem in Busch Conservation Area lakes, they are likely not a problem in surface water to the south. However, ATSDR recommends that DOE samples collected during ongoing remedial investigations at Little Femme Osage be analyzed for metals and nitroaromatics contamination to confirm that there is no problem in waters to the south.

- Consumption of potentially contaminated spring water within the conservation areas should be restricted through the implementation of institutional controls, such as educational materials provided to visitors, and warning signs at affected springs.

- Nitroaromatic and lead contamination are present in localized portions of the conservation areas. Access to all areas with known chemical contamination should continue to be restricted until soil remediation is completed.

- Measures should be continued to protect the public from the physical hazards presented by derelict structures and debris remaining in place throughout the former WSOW areas outside Army and DOE control.

Offsite

- The state should continue to monitor private wells for site-related chemicals. The present sampling and analysis methods are appropriate.

PUBLIC HEALTH ACTIONS

The public health action plan (PHAP) for the Weldon Spring Former Army Ordnance Works NPL site contains a description of actions to be taken by ATSDR and/or other governmental agencies at and in the vicinity of the site subsequent to the completion of this public health assessment. The purpose of PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR to followup on this plan. The public health actions to be implemented are as follows:

Actions Planned

1. ATSDR will continue to coordinate with Army, EPA and state agencies to assure that recommendations are implemented.

2. The state of Missouri will continue to monitor private groundwater wells in the vicinity of WSTA.

3. ATSDR will review the remedial activities at WSTA, to evaluate the proposed remediations in relation to protection of public health. ATSDR comments, and recommendations, as appropriate, will be provided to EPA, the Army and State of Missouri.

4. ATSDR will continue the development of a public health assessment for public health issues regarding the DOE NPL site facilities at Weldon Spring.

ATSDR will reevaluate and modify the Public Health Action Plan as needed. New relevant data, or the results of implementing the above proposed actions may determine the need for additional actions at this site.

PREPARERS OF REPORT

Jeff Kellam, M.S.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Lorna L. Bozeman, M.S.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

ATSDR Regional Representative:

David Parker
ATSDR, EPA Region VII
Kansas City, KS

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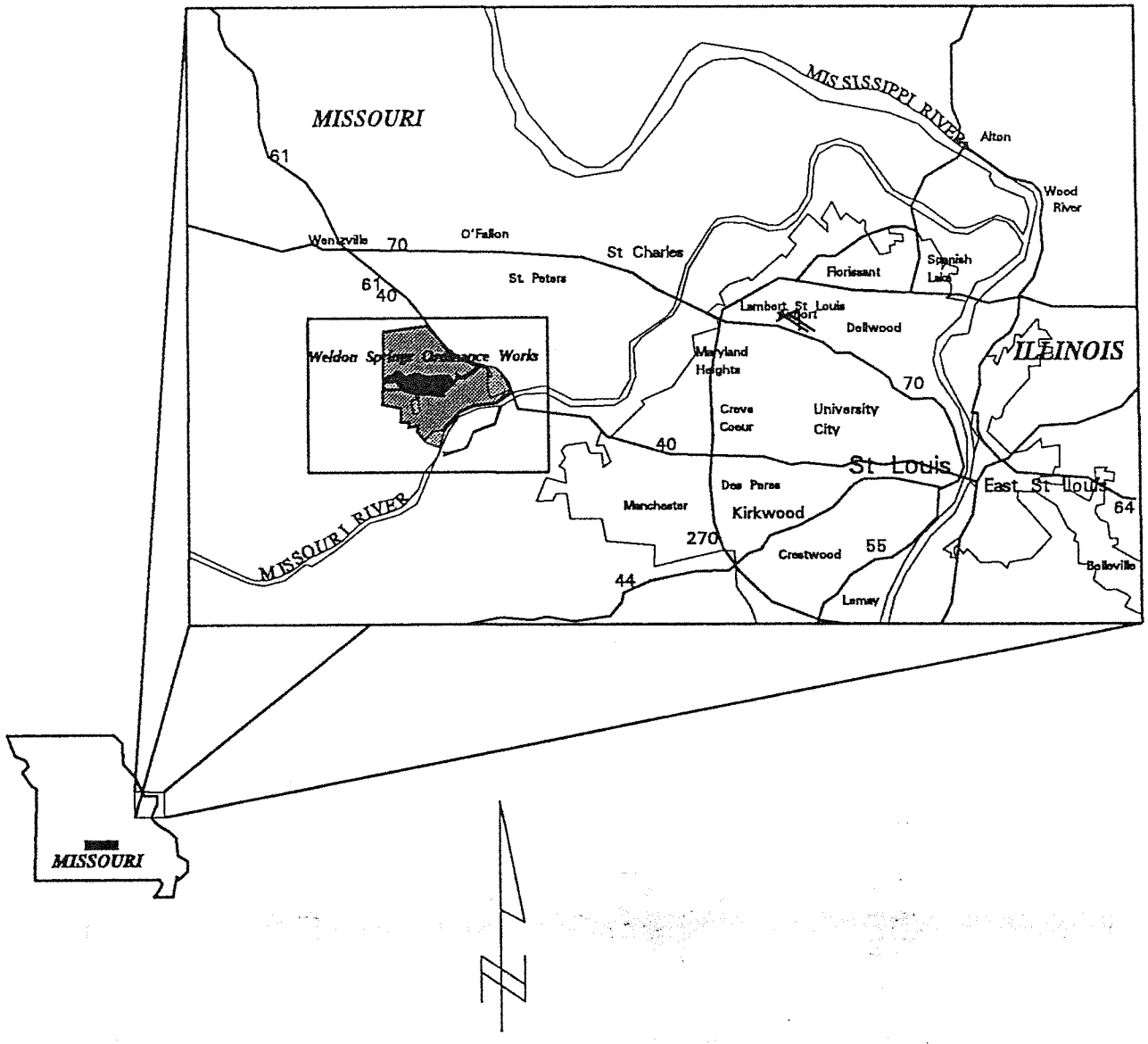
FIGURES

Location Map
Weldon Spring Area

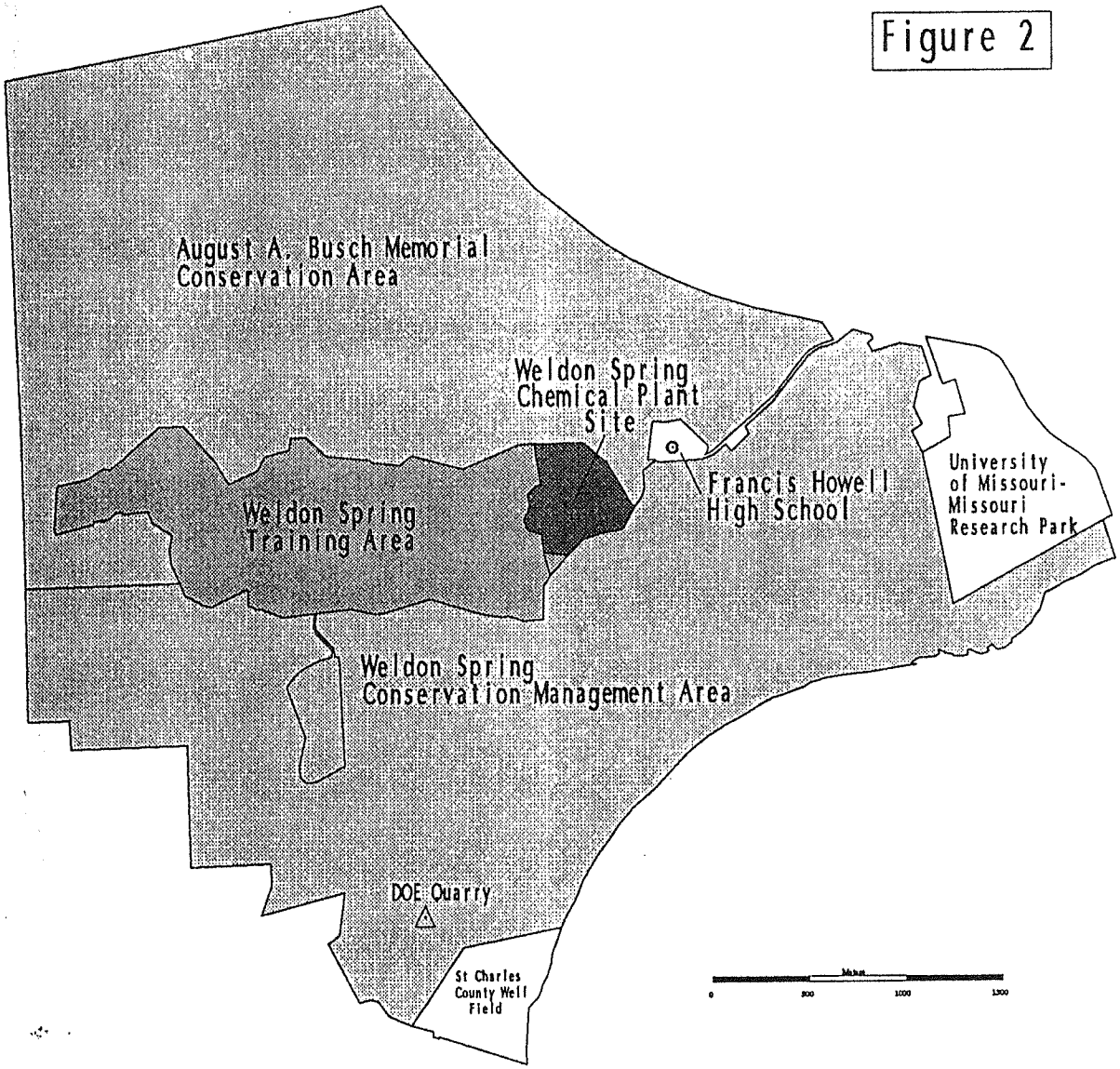
Figure 1



Source - 1990 US CENSUS, USACE/DOE

ATSDR GIS Spatial Analysis Activity

Figure 2



Weldon Spring Study Area

Weldon Spring, MO

LEGEND

- Study Area Boundaries
- DOE Chemical Plant
- Training Area
- Conservation Areas

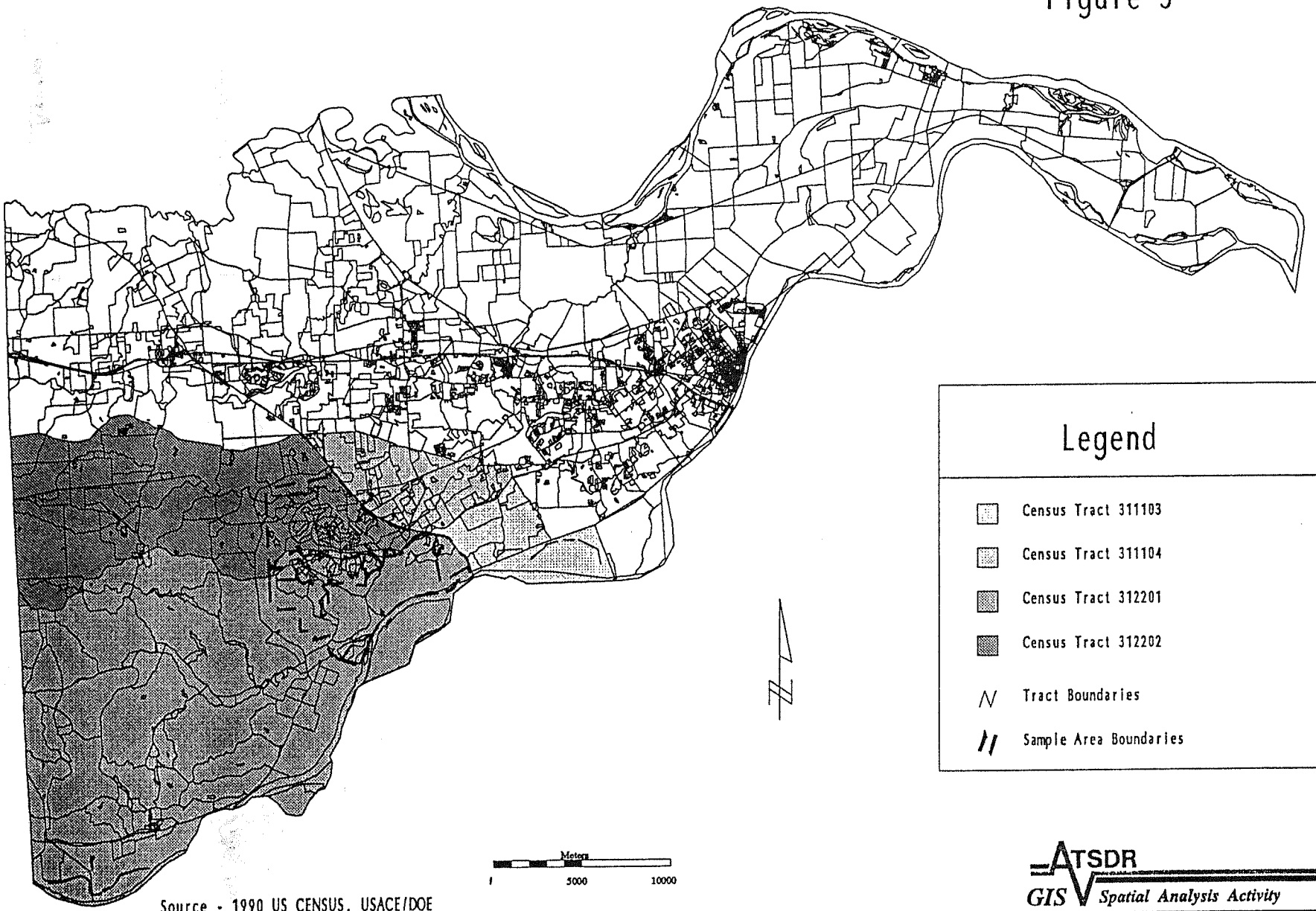
Source - 1990 US Census & USACE/DOE

ATSDR GIS Spatial Analysis Activity

1990 St. Charles County, MO Census Tracts

Weldon Spring Area

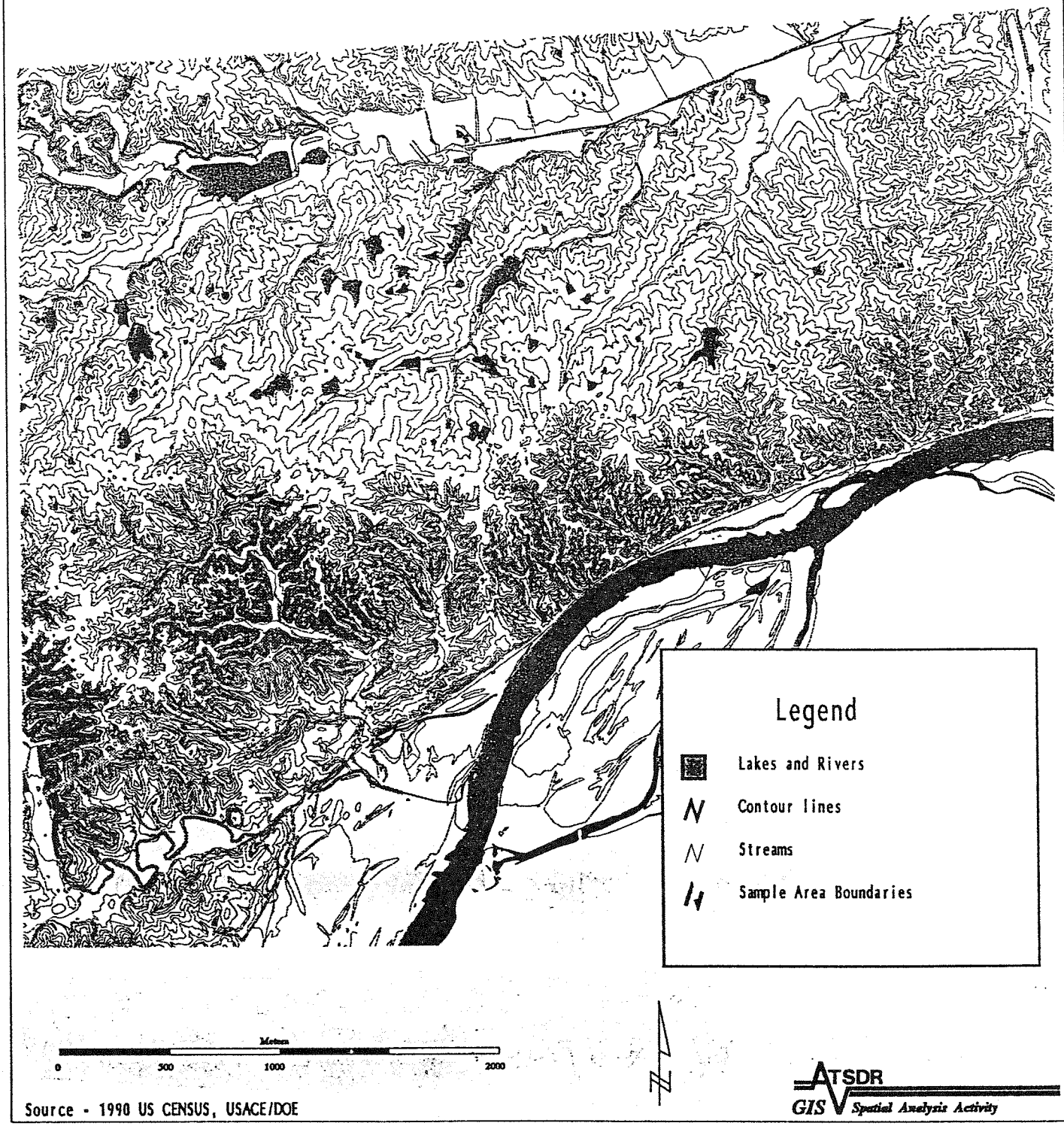
Figure 3



Hydrography

Weldon Spring Area

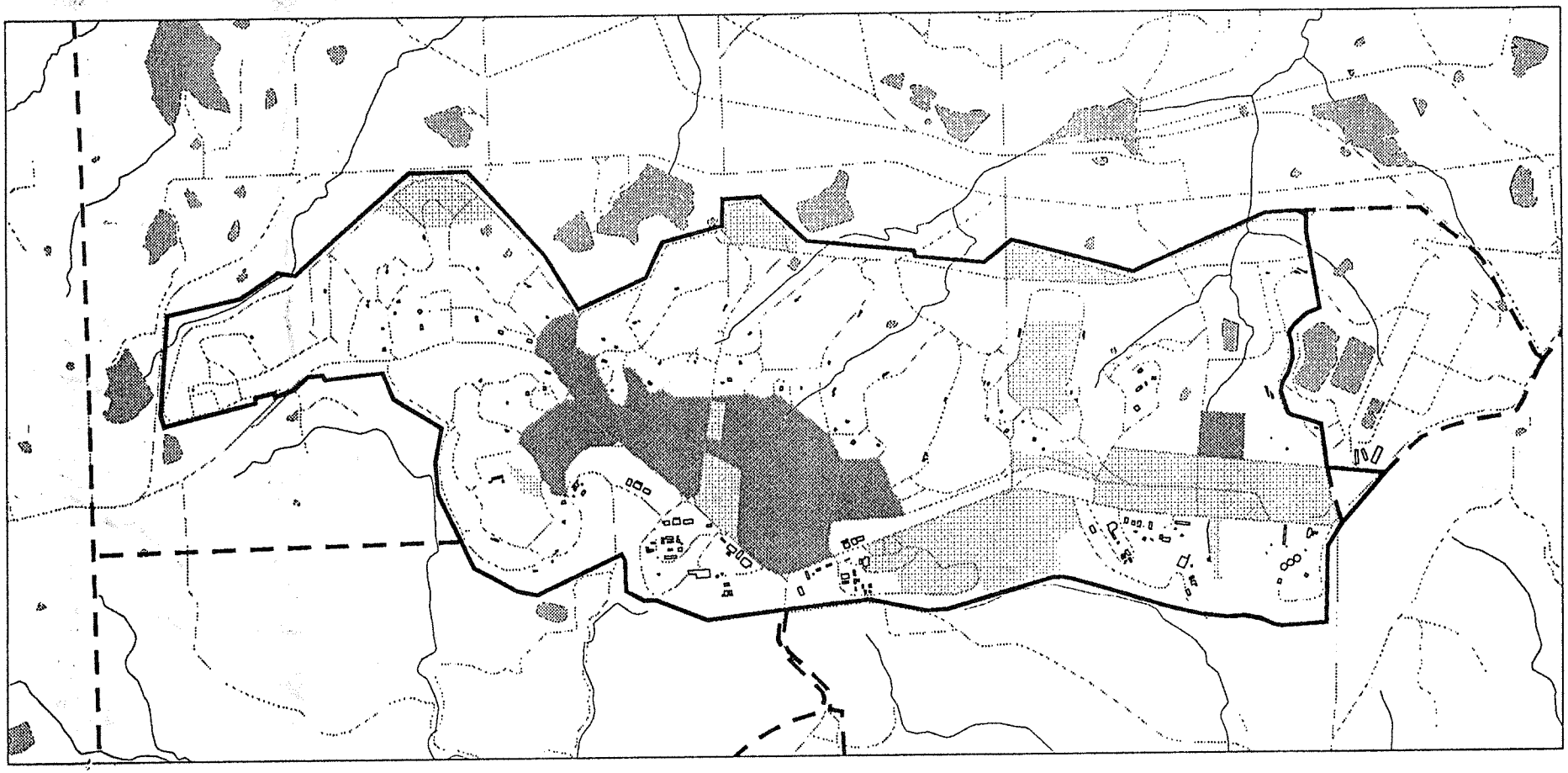
Figure 4



Current and Proposed Training Areas in WSTA

Weldon Spring Area

Figure 5



Lakes
Current Training Areas
Proposed Training Areas
Buildings

Roads
Rivers & Streams
Sample Area Boundaries

Not To Scale

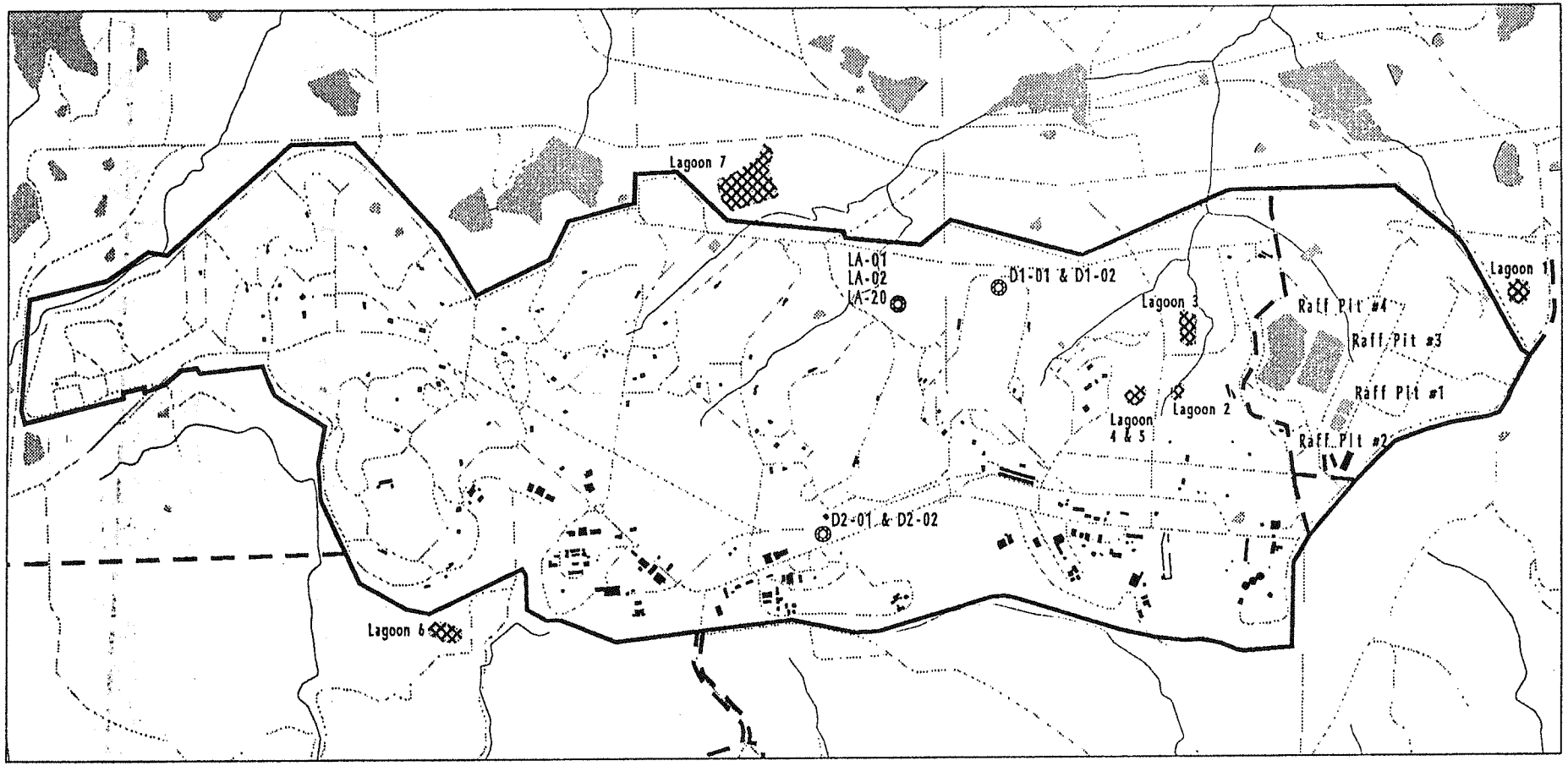
Source - TIGER files & USACE/DOE

ATSDR GIS Spatial Analysis Activity

Waste Water Treatment Facilities at WSTA

Weldon Spring Area

Figure 6



Roads
Streams
WSCW Boundary Lines
Pipelines
Waste Lagoons
Lakes
Buildings and Ruins
Dump Sites

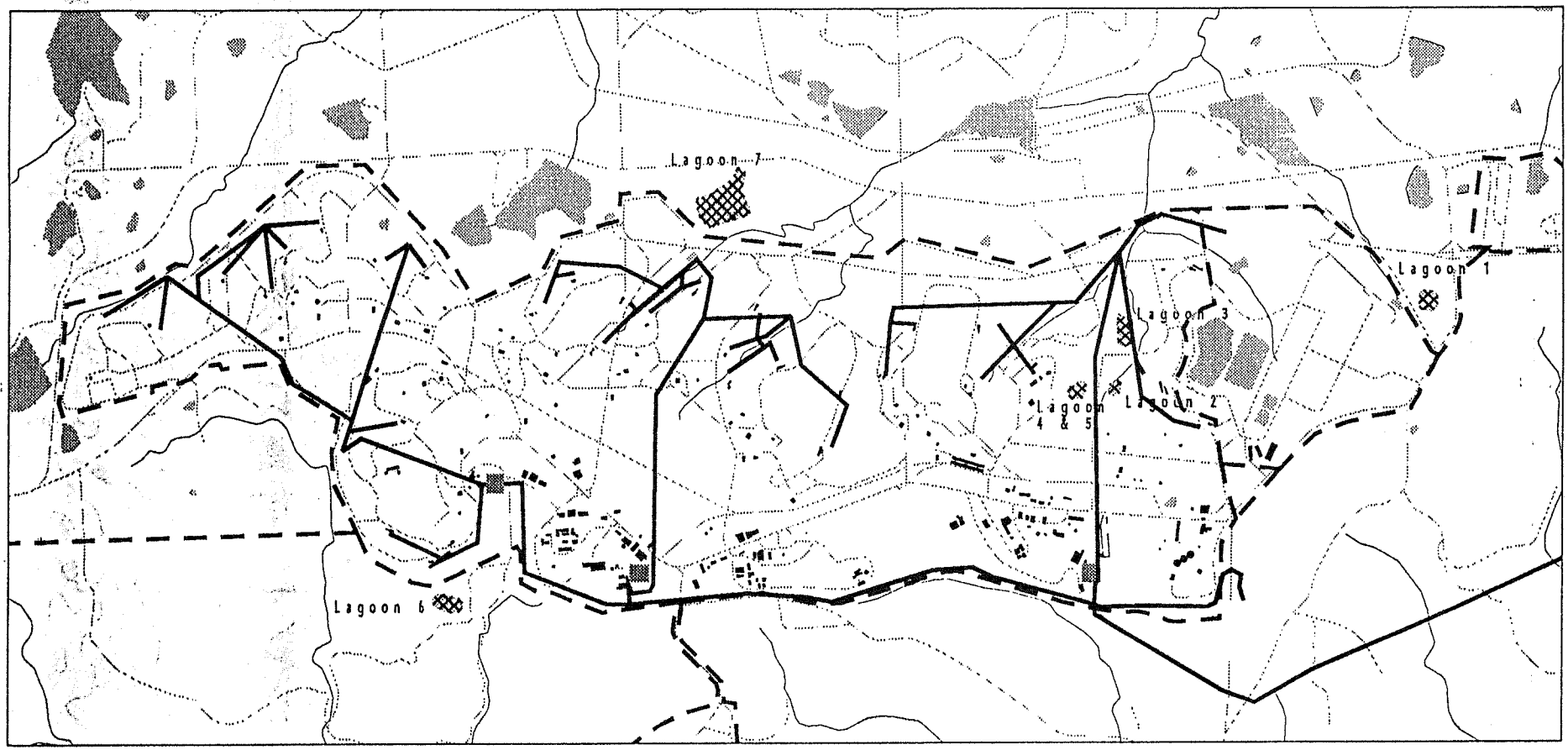
Meters
0 500 1000 2000

ATSDR GIS Spatial Analysis Activity

Waste Water Treatment Facilities at WSTA

Weldon Spring Area

Figure 7



Roads
Streams
WSOW Boundary Lines
Pipelines
Waste Lagoons
Wastewater Treatment Plants
Lakes
Buildings and Ruins

Not To Scale

ATSDR GIS Spatial Analysis Activity

Potential Contamination Areas in WSTA

Weldon Spring Area

Figure 8

TNT Sample Points
WSOW Boundary Lines
Pipelines
Contour Lines
Lakes
WSTA Buildings and Ruins

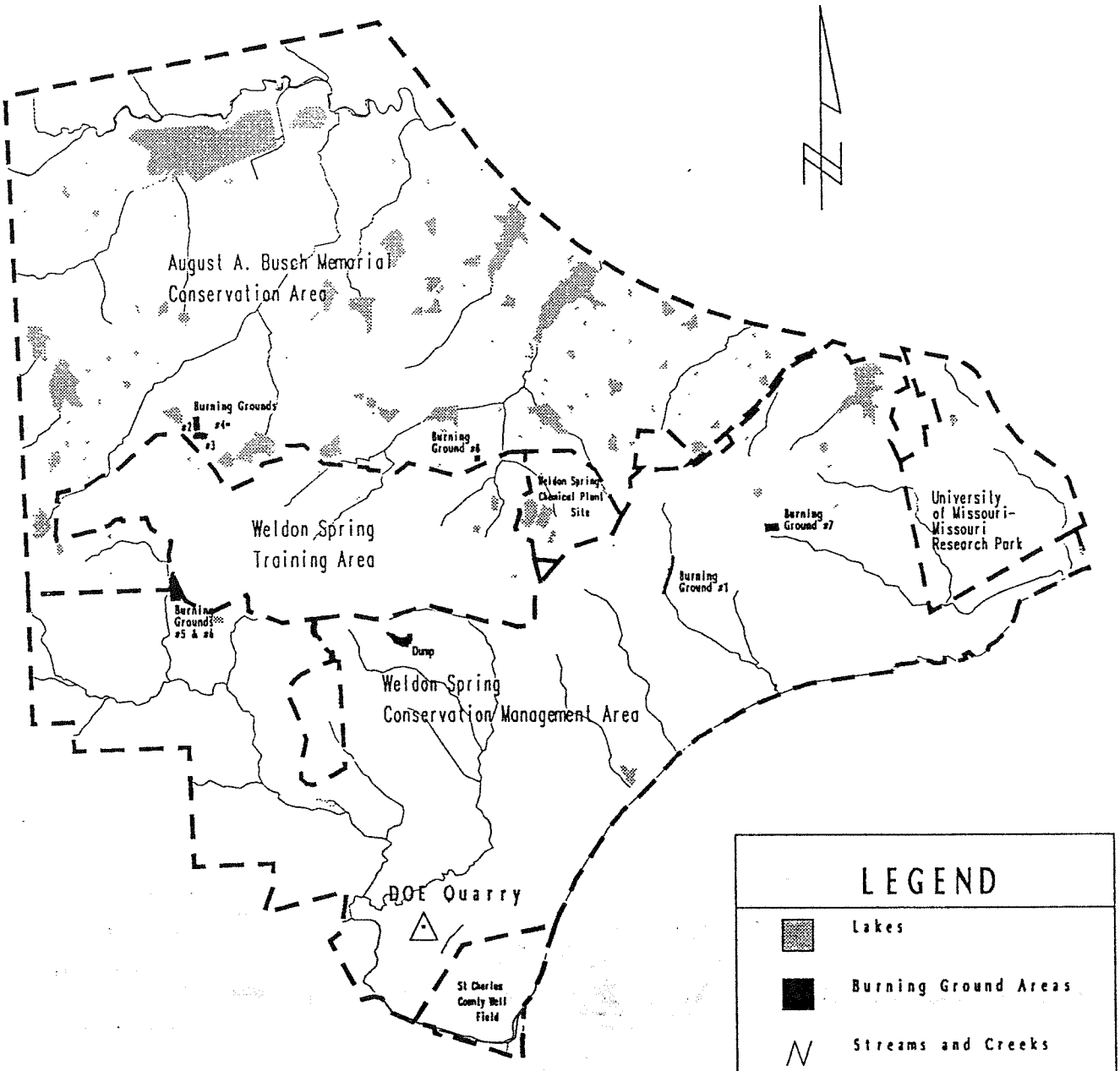
Meters
500 1000 2000

ATSDR GIS Spatial Analysis Activity

Location of Burning Grounds

Weldon Spring Area

Figure 9



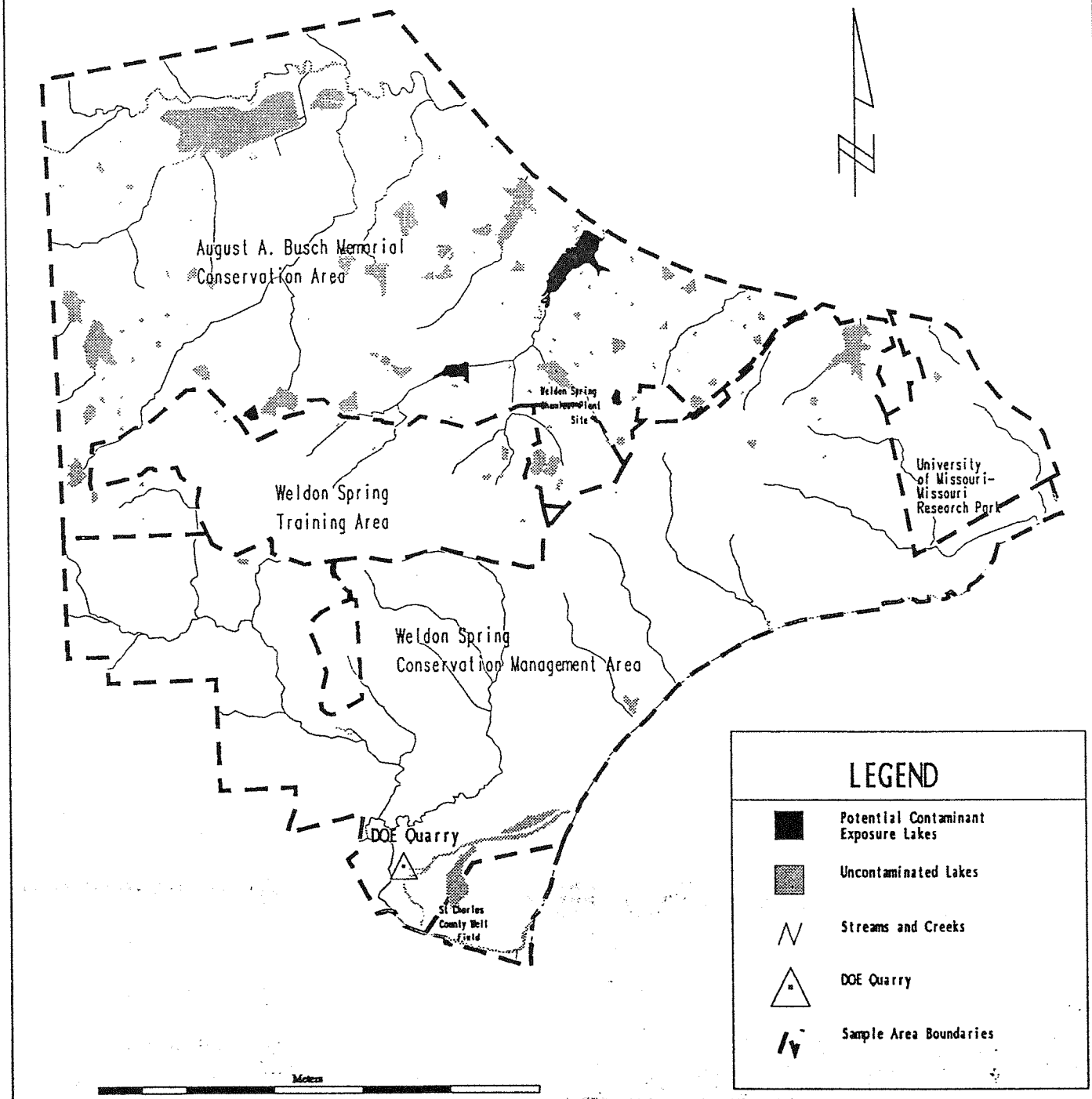
Source - 1990 US CENSUS, USACE/DOE

ATSDR GIS Spatial Analysis Activity

Lakes With Potential Biota Contamination

Weldon Spring Area

Figure 10



Source - 1990 US CENSUS, USACE/DOE

ATSDR GIS Spatial Analysis Activity

TABLES

TABLE 1: WSTA Contaminant Pathway Evaluation

Pathway	Contamination Location	Exposure	Receptor Population\Population Size	Current Path
Groundwater	WSTA, conservation areas (springs) and offsite wells	drinking water, dermal contact	conservation area visitors\unknown	yes*
			past private wells (Twin Island Lakes Resort)\none	no
Soil	WSTA and conservation areas	access restricted	site workers and infrequent trespassers\unknown	possible **
Biota	possibly on and offsite	consumption of game and fish	onsite trespassers, hunters and anglers offsite\unknown	possible ***

* Incidental ingestion is not sufficient to result in adverse health effect

** Contact with contaminated soil is restricted by institutional controls.

*** Adverse health effects unlikely due to low levels of contaminants in fish and infrequent consumption

Table 2: Surface Water Contaminants

Water Body	Contaminant(s)	Concentrations
Lake 10	1,3,5 TNB	0.08 ppb
	o-nitrotoluene	0.06 ppb
Lake 23	1,3,5 TNB	0.11 ppb
	m-nitrotoluene	0.07 ppb
	p-nitrotoluene	0.06 ppb
Lake 32	o-nitrotoluene	0.06 ppb
Lake 35	p-nitrotoluene	0.07 ppb
	1,3,5 TNB	0.1 ppb
Lake 36	1,3,5 TNB	0.08 ppb
Hampton Lake	m-nitrotoluene	0.27 ppb
	o-nitrotoluene	0.12 ppb

From:(1) Contaminant detections do not exceed CVs.
TNB CV = 0.5 ppb
No CV for m-, n-, o-, p-nitrotoluene, for comparison 2,4-DNT CV = 20.0 ppb, 2,4,6-TNT CV = 1.0 ppb

NOTE: Nitroaromatic contaminants not detected in former lagoons.

Table 3: Former Groundwater Well Usage at Twin Island Lake Resort

From:(4)

ID Number	Depth	Description and Use
#1	111 Ft.	Potable water to campsites. Connected to #61.
#2	220 ft	Potable water to sites. Not used "very often" water is rusty. Connected to #4.
#3	90 ft.	Potable water to sites and resort office.
#4	235 ft.	Potable water to sites. Connected to #2.
#61	?	Potable water to owner's house and sites. Connected to #1.
Swim Lake Well	630 ft.	Water for swimming lake only.
Goldfish Pond Well	12 ft.	Water to goldfish pond used only for children's catch and release fishing.

Table 4: Past Test Results from Twin Island Lake Resort Wells Range of Concentrations (ppb) from Six Sample Runs (1989)

From: (4)

Well ID#	#1	#3	#4	#61* *Owner's private well	Goldfish Pond
Chemicals					
2,4,6-TNT *CV - 1.0/CREG C	0.2 - 0.32	0.03 - 0.6	<0.03 - <0.25	0.04 - <0.25	0.03 - 0.04
2,4-DNT CV - 20.0/EMEG child	0.03 - 0.05	<0.02 - 0.07	<0.02	<0.02	<0.02
2,6-DNT CV - 400.0/CLHA	0.03 - 0.17	0.08 - 0.19	<0.01	<0.01	0.05 - 0.07
1,3,5-TNB CV - 0.5/RMEG child	0.14 - **1.16**	0.1 - **1.8**	<0.03	<0.03 - **1.0**	<0.03
1,3-DNB CV -1.0/LTHA and CREG D	<0.09	<0.09 - 0.2	<0.09	<0.09	<0.09

* CV - ATSDR Comparison Value

APPENDIX A
Abbreviations and Acronyms

AEC - Atomic Energy Commission
ATSDR - Agency for Toxic Substances and Disease Registry
CERCLA - Comprehensive Environmental Response Compensation and Liability Act, or Superfund
CLHA - Child Longer-Term Health Advisory
COE - (U.S. Army Corps of Engineers
CREG - Cancer Risk Evaluation Guides
CSF - Cancer Slope Factors
CV - (ATSDR) Comparison Value
DOE - U. S. Department of Energy
EFAS - (ATSDR Division of Health Assessment and Consultation) Energy Facilities Assessment Section
EMEG - Environmental Media Evaluation Guides
EPA - U.S. Environmental Protection Agency
ft. - feet/foot
IQ - Intelligence Quotient
kg - kilogram
L - liter
LOAEL - Lowest Observable Effects Level
LTHA - Lifetime Health Advisory
MDOC - Missouri Department of Conservation
mg - milligram
MGD - Million Gallons per Day
mg/kg - milligram per kilogram
mg/L - milligrams per liter
MRL - Minimal Risk Level
NPL - National Priorities List
NOAEL - No Observable Adverse Effect Level
OSHA - Occupational Safety and Health Administration
PAHs - Polycyclic Aromatic Hydrocarbons
PCBs - Polychlorinated Biphenyls
PHAP - Public Health Action Plan
ppb - part per billion

ppm - part per million
RI - Remedial Investigation
RI/FS - Remedial Investigation/Feasibility Study
RMEG - Reference Media Evaluation Guide
SVOC - semivolatile organics
TCLP - Toxicity Characteristic Leaching Procedures
WSCP - Weldon Spring Chemical Plant
WSOW - Weldon Spring Ordnance Works
WSSRAP - Weldon Spring Remedial Action Project
WSTA - Weldon Spring Training Area
WW I - World War I
WW II - World War II
1,3-DNB (DNB) - Dinitrobenzene
1,3,5-TNB (TNB) - Trinitrobenezene
2,4-DNT (DNT) - Dinitrotoluene
2,6-DNT (DNT) - Dinitrotoluene
2,4,6-TNT (TNT) - Trinitrotoluene

APPENDIX B
Description of ATSDR Comparison Values

The conclusion that a contaminant exceeds the CV does not mean that it will cause adverse health effects. CVs are contaminant concentrations in specific media that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects.

Background concentrations

Background concentrations for the state, region, or nation can be used for comparison, when background samples for the medium of concern, such as soil, have not been collected and when other comparison values do not exist. Background concentrations can be used provided the medium has the same basic characteristics as the medium of concern at the site.

Cancer Risk Evaluation Guides (CREGs)

CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10E-6) persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs).

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels (MRLs) and factor in body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without an noncarcinogenic effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

Lifetime Health Advisory (LTHA)

An LTHA represents contaminant concentrations that EPA considers protective of noncarcinogenic health effects during a lifetime (70 years) of exposure. Drinking water concentrations are developed to predict acceptable exposure levels for both adults and children when data on a NOAEL or LOAEL exist from animal or human studies. LTHAs are not legally enforceable standards.

Reference Media Evaluation Guide (RMEG)

RMEGs are derived by ATSDR from the EPA oral Reference Dose. It is the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncancerous effects.

Reference Dose (RfD)

An RfD is EPA's estimate for the human population (including sensitive subpopulations) of the daily exposure by the oral route likely to be without appreciable risk of deleterious noncarcinogenic effects during a lifetime (70 years) of exposure.

Child Longer-Term Health Advisory (CLHA)

A CLHA is derived by EPA. It is a drinking water concentration at which adverse, noncarcinogenic health effects would not be expected to occur in children after exposure up to 7 years in duration.

APPENDIX C
Polycyclic Aromatic Hydrocarbons in Surface Soils at WSTA

PAH Surface Soil Contaminants at WSTA		
Compound	**Maximum Concentration mg/kg**	**Comparison Value**
benz(a)anthracene	3.1	EPA B2 no numeric value
benzo(a)pyrene	2.2	0.1 CREG
benzo(ghi)perylene	0.99	none
benzo(k)fluoranthene	7.4	EPA B2 no numeric value
chrysene	7.4	EPA B2 no numeric value
ideno(123cd)pyrene	1.1	EPA B2 no numeric value
phenanthrene	8.3	none

Appendix D
Evaluation of Incineration

The Proposed Plan for remediation for Operable Unit One at WSTA envisions incineration as an alternative for treatment for much of the contamination at the site. Incineration is a remedial alternative which can be a concern to members of the public in terms of its safe use. ATSDR will review the proposed plans for any of the remedial alternative chosen. However, due to the potential high level of interest in incineration, a preliminary evaluation is provided here.

As proposed, incineration will be used to remediate the pipelines and contaminated soil. Groundwater and surface water contamination will be dealt with in the future proposed plans for Operable Unit Two. Remediation for these media will be determined as the effect of soil remediation is evaluated, with the expectation that soil remediation will remove the source of groundwater and surface water contamination (3).

Based on their evaluation of various alternatives, the Army and EPA support incineration of soil contaminated with nitroaromatics, PAHs, and PCBs, and incineration of the waste water pipelines.

The incinerator is a natural gas-fired rotary kiln which will heat the contaminated material to about 1200 degrees Fahrenheit (°F), volatilizing the nitroaromatics. These nitroaromatics are then carried into a secondary combustion chamber and destroyed at about 1700°F. Dust particles are then separated and any remaining gases are treated in a wet scrubbing system, baghouse or electrostatic precipitator (23). Currently, ATSDR does not have information on which of these processes will be employed.

EPA will monitor the process to ensure that the incinerator destroys or removes 99.99% of the contaminants (23). Due to the relatively high lead levels in the soil, air pollution control equipment that is very efficient in removing lead and particulates,including asbestos, will be very important for the safe and effective operation of this unit (24).

According to specifications written by EPA, monitoring will be continuous and instantaneous, so that in the event that requirements are not met for any reason, the process can be immediately shut down. The effluents resulting from the process are to be a gas stream which meets requirements protective of human health, and incinerated soil, which may contain nitroaromatics, but at a level which will also not be a threat to human health (3).

Soil contaminated by nitroaromatics will be incinerated and will backfilled into the original excavations. Nitroaromatic- and lead-contaminated soil will be incinerated, stabilized and

Construction debris will be disposed in an onsite landfill. Lead-contaminated soil will be contained in an onsite landfill. The landfill intended for containment of lead-contaminated soil will be double-lined on sides and bottom, with a leachate collection system and leak detection system (3). The WSOW FS states that each landfill would be required to meet RCRA requirements for soil, geologic and hydrologic conditions, liners, monitoring systems, leachate collection, operation, maintenance and service facilities. These requirements are specified by RCRA Subtitle C hazardous waste regulations in 40 CFR 264 and by land disposal restrictions specified in 40 CFR 268. Lead-contaminated soils would be required to pass Toxicity Characteristic Leaching Procedure (TCLP) testing. RCRA also requires that any nitroaromatic-contaminated soils be treated to reduce or eliminate reactivity (6).

The proposed plan (3) for remediation of on-site soils contains insufficient information on the design of the incinerator to estimate what the impacts may be on the local community. However, thermal destruction (incineration) is probably the most effective way to destroy the TNT and DNT present, and a properly designed and operated incinerator can be run in a manner to be protective of public health. If appropriately stringent precautions are maintained, use of the incinerator described can be protective of public health (24). As previously stated, ATSDR will review, for the effect on public health, all proposed work plans for remedial alternative(s) chosen.

APPENDIX E
Toxicological Evaluations

Nitroaromatics

The following is a brief description of the health effects of exposure to nitroaromatics. The understanding of the effects on humans are based on the evaluation of exposure by way of inhalation of pure product during manufacturing activities. The concentrations in soil are obviously many orders of magnitude smaller that those which would have been encountered in the production facilities by workers. And, once again, the current exposures expected are short-term and infrequent.

It was during large-scale production of TNT during WW I that the toxic effects of TNT were first well documented. Many workers in munitions factories died of TNT intoxication. With application of hygienic precautions (such as periodic hand-washing, routine changes of protective clothing, and respiratory protection) to prevent inhalation exposure, fatalities decreased. Liver disease and aplastic anemia (an often fatal bone marrow disorder that causes anemia and other changes in the blood) were the primary causes of death. Absorption of TNT through the skin or lungs can produce cyanosis (lack of oxygen-carrying capacity of the blood), severe liver damage, anemia, cataract formation, CNS manifestations, and kidney damage.

Long-term, low-dose TNT-ingestion studies have been carried out in mice, rats, and dogs. At higher doses in mice and rats over a 24 to 26-week period, hematological signs of anemia and liver damage were noted. When dogs were fed TNT over 26 weeks, liver damage was noted at all dosage levels. Increased incidence of urinary bladder papilloma (benign adn cancerous tumors of the urinary baldder) and carcinoma was found in female rats. Using this study, EPA classified TNT as a Group C chemical (possible human carcinogen). It should be emphasized that these effects were the result of **long-term** exposure by ingestion, and not based on infrequent, incidental exposures such as would be expected to occur to site trespassers.(51)

No information is available on the health effects of TNB. Because of its structural similarity to DNB, assumptions are made that its health effects might be similar to those caused by DNB. Data about health effects after exposure to DNB are limited. Six workers exposed to an unknown concentration of 1,3-DNB dust developed cyanosis that began within one day of exposure and lasted two weeks. Health effects also included anemia accompanied by palpitations, dizziness, and fatigue. Anemia persisted an average of three days. Follow-up examinations over a 10-year period did not reveal any adverse health effects. Well-documented health effects in animals include toxic effects resulting in death and pathological

effects on the liver, spleen, and testes. These effects resulted in weight loss, anemia, and decreased reproductive capacity. Some evidence of increased toxicity in older (as compared to younger) animals was noted. A 16-week study of ingestion by rats of 1,3-DNB in drinking water detected both splenic and testicular effects. High uncertainty factors were included because of lack of long-term studies. DNB is considered a Class D chemical (not classified as to human carcinogenicity) because of lack of information about its carcinogenicity. Because of the uncertainty of using DNB studies to develop guidelines for TNB, additional safety assumptions were included in the calculations(51). Here again, as is the case with TNT, the effects noted are for **long-term** ingestion, not infrequent, incidental exposure as would occur with trespassers or with infrequent ingestion of surface water.

Lead

The effects of lead once it is in the body are the same, regardless of how it enters the body. Exposure to lead is especially dangerous to unborn children, infants and young children. For infants and young children, lead ingestion has been shown to decrease intelligence scores (IQ), slow growth and cause hearing impairment. Exposure to high lead levels can cause brain and kidney damage in both children and adults. The ability of lead to cause cancer in humans has not been shown. To date, workplace studies do not provide enough information to determine the risk to workers of cancer from lead exposure. However, some research with rats and mice have shown tumors will develop in subjects fed large doses of lead.(52) The concentrations of lead in some soil samples at WSTA are elevated to the point where exposure may reasonably be considered a hazard.

PCBs

EPA has classified PCBs as probable human carcinogens. Human studies show that acne-like rashes can occur in occupational exposures to PCBs. Other studies of occupational exposure suggest that PCBs might cause liver cancer. Reproductive and developmental effects may result from occupational exposure. It must be emphasized that these effects are not definitively proven(53).

Asbestos

The U.S. Department of Health and Human Services has determined that asbestos is a known carcinogen. Information on health effects of asbestos in humans comes from studies of workers exposed to high levels of asbestos in the workplace. Increased incidence of lung cancer and mesothelioma (a tumor of the lining of the lung and chest cavity) were seen in

these worker studies. Both types of cancer are usually fatal. These diseases develop over a period of years. There is also evidence that increased incidence of other cancers (e.g. stomach, intestines, esophagus, pancreas, kidneys), but this is less certain. Members of the public exposed to lower levels may be at increased risk for cancer, but the risk is usually small and difficult to verify. Exposure via inhalation also poses the risk of scarring of the lungs, termed asbestosis (a disease characterized by deposits of fibers in the lung, causing difficulty in breathing). This disease causes difficulty in breathing and decrease in blood flow in the lungs. Asbestosis is a serious illness, in most cases resulting from exposure to high levels of asbestos via inhalation. There is little evidence that exposure via consumption of asbestos results in negative health effects. (54)

APPENDIX F
Groundwater Contaminants at WSTA

Table 2: Groundwater Contaminants at WSTA

Aquifer Total wells	Contaminants	Contaminant Levels (ppb)	ATSDR Comparison Value (ppb)
Overburden Aquifer	2,4 DNT	8.5	20 chronic EMEG child
	2,6 DNT	5.1	400 intermediate EMEG child
	1,3,5 TNB	7.3	0.5 RMEG child
	2,4,6 TNT	1.0 - 12.0	1.0 CREG
	cadmium	22.0	2.0 CREG
Shallow Bedrock Aquifer	2,4 DNT	0.96 -1.0	20 chronic EMEG child
	2,6 DNT	0.34 - 3.8	400 intermediate EMEG child
	2,4 DNB	0.49	1.0 LTHA, CREG
	nitrotoluene	0.16 - 1.2	none
	1,3,5 TNB	0.13 - 2.5	0.5 RMEG child
	2,4,6 TNT	0.56 - 5.8	1.0 CREG
	cadmium	100.0 - 115.0	2.0 CREG
	manganese	10.0 - 420.0	50 ppb RMEG child
Deeper Bedrock Aquifer	2,4,6 TNT	0.19 - 12.0	1.0 CREG
	cadmium	11.0 - 20.0	2.0 CREG

APPENDIX G.
Comments on Weldon Spring Ordnance Works Public Health Assessment

The following responses were received during the public comment period. This list of comments does not include editorial comments concerning word spellings, sentence syntax, etc. It does not include comments on accuracy of stated facts. If the accuracy of a statement was questioned, the statement was verified or corrected. The portions of the comments below that are in parentheses were paraphrased by ATSDR for brevity or clarity. If the same comments were received from more than one source, only one comment and response is listed.

Comment 1: (Document) does not mention the WSOW public meeting hosted by the Corps of Engineers on November 20, 1992. This was a significant meeting that alerted ATSDR to new cancer concerns not previously addresses.

> Site Visit section has been modified to reflect this comment.

Comment 2: (Demographic section) could more meaningfully say that population is sparse, older, and rural to the west of the site and dense, younger, and suburban to the east.

> PHA demographics section reflects information from the 1990 Census concerning population in the area immediately surrounding the WSOW. While population density does increase to the east, toward St. Louis, the area of interest to this PHa is that of the immediate vicinity of WSOW.

Comment 3: The environmental pathways discussion ... does not mention the common regulator concern that rather than "Chemicals routinely manufactured, handled, and stored at WSOW", it is their degradation products that are *perhaps* (italics added) more dangerous. In their number and variety, degradation products are more difficult to study and assess.

> This PHA addresses contaminants determined to be present at WSOW based on data collected in the Remedial Investigation process. Also evaluated are the potential for exposure of the public to these chemicals. Where toxicological studies are not available on specific breakdown products, assumptions are made based on toxicological information available on the original chemicals, using conservative safety factors. Additionally, the potential for exposure of the public to breakdown products is no more likely than it would be for the original chemicals. For these reasons, this document assumes no more threat to the public health from breakdown products than from the original ordnance chemicals.

Comment 4: The "Report on Childhood Leukemia in St. Charles County" covered a period from 1970 to 1983. Since the data may

be over 25 years old, shouldn't more recent studies be selected? Have broader cancer studies specific to the area been undertaken?

The study encompassed a period of 14 years, ending about 12 years ago. This is the most recent study available. To this time, no "broader" studies have been conducted.

Comment 5: Plans are now being finalized to combine the WSOW landfill into the WSSRAP cell. This will eliminate the need for two landfills to exist side-by-side with associated long-term monitoring.

Appendix D is based on ROD information available to ATSDR at the time of publication of this PHA. In the event that a combined landfill is authorized it will offer the advantages suggested by the comment.

Comment 6: On P. 17 reference is made to groundwater contamination by heavy metals. In particular cadmium is mentioned as found at elevated levels. This is substantiated in appendix F where cadmium is clearly above ATSDR's CV's at all three aquifer levels. In the assessment of health risks associated with possible onsite migration of contaminants in groundwater (P 26-27) no mention is made of heavy metals or cadmium in particular. Has cadmium been sampled for? If it was sampled for and was not detected at levels that pose a risk, this information warrants inclusion in this section. If it has not been sampled for, what is ATSDR's position on this, based upon the high levels found all three aquifer levels? No mention was made of cadmium's presence or absence at the St Charles County Water Departments wells, just nitroaromatic compounds. Is there monitoring information to resolve this informational void?

We appreciate this being brought to our attention. Information from the WSOW Baseline Risk Assessment has been incorporated into the text. Samples from 53 offsite wells were analyzed for chemicals of potential concern, including cadmium. Two well contained cadmium at or above the detection level. The maximum concentration found was 0.3 ppb, well below the ATSDR CV of 2.0 ppb.

The St. Charles County Well Field uses water from the Missouri River alluvial aquifer and is not likely to be affected by contaminants in the aquifers under WSOW. According to information provided by WSOW, St. Charles County maintains a testing and treatment program for drinking water contamination, including metals such as cadmium. Levels measured at the wellfield are within the required EPA limits for cadmium in drinking water (less than 5.0 ppb) (55).

Comment 7: The third paragraph under the first page of conclusions concerning ATSDR's opinion of the protective nature of a "properly designed and operated incinerator" seems a bit premature in light of the qualifications expressed in the

preceding sentence. It could also be said that a properly designed and improperly operated incinerator might not be protective of public health. I feel it is inappropriate at this early stage to be making a veiled endorsement of a technology unless your agency can reference experience from other sites where this type of technique has been used on the same matrix of compounds. It may well be that this is the proper technology from a public health perspective, However, there is very little in your document to support this assertion and any position on its desirability or non-desirability should therefore be stricken.

ATSDR remains committed to the position that a properly designed and operated incinerator is a safe and effective method for remediating soil contamination of the type found at WSOW. As long as proper engineering and monitoring are maintained throughout the operation, the nitroaromatics can be destroyed without release of lead or other contaminants into the environment. State and federal regulators will be acting to ensure that operations are safely conducted. Any reservations expressed in Appendix D relate to ATSDR's desire to provide expert review and evaluation of the incinerator and operating plans prior to our final endorsement. As an advisory agency, ATSDR does not have the authority to approve or disapprove of the incineration program. However, both the EPA and state regulators have been completely receptive to our input at this site.